Fishery Data Series No. 25-20

2022 Southeast Alaska Herring Stock Assessment Surveys

by

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Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
Federal Information Code	FIC
id est (that is)	i.e.,
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	′
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	″
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 25-20

2022 SOUTHEAST ALASKA HERRING STOCK ASSESSMENT SURVEYS

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ABSTRACT

Pacific herring *Clupea pallasii* are important prey for many marine species found in Southeast Alaska and are harvested in fisheries for subsistence, personal use, commercial, and research purposes. The Southeast Alaska Herring Management plan (5 AAC 27.190(3)) requires the Alaska Department of Fish and Game to assess the abundance of mature herring for each stock before allowing commercial harvest. Included here are results of stock assessment surveys completed primarily during 2022, including summaries of herring spawn deposition surveys and age-weight-length sampling, which are the principal model inputs used to forecast herring abundance. In 2022, spawn deposition surveys were conducted only for Sitka Sound, Craig, and Revilla Channel area stocks. Spawn deposition surveys were not conducted in several other traditionally major spawning areas due to lack of funding or low levels of observed spawn, although aerial surveys of spawning were continued on a limited basis. The shoreline in state waters where spawn was documented in Southeast Alaska and Yakutat during aerial surveys for major spawn areas in 2022, combined for all areas, was 146.3 nautical miles. Post-fishery spawn deposition biomass estimates, combined for all surveyed stocks, totaled 246,849 tons. During the 2021–2022 season, a commercial winter bait fishery was opened in Craig with a guideline harvest level (GHL) of 7,590 tons. A commercial purse seine sac-roe fishery was opened in Sitka Sound with a GHL of 45,164 tons. A commercial spawn-on-kelp fishery was open in Craig with an allocation of 12,252 tons of herring, allowing for the highest possible kelp allocation for pounds. There were no other commercial herring fisheries opened during the 2021–2022 season. Herring harvested commercially during the 2021–2022 season totaled 25,488 tons, not including herring impounded for spawn-on-kelp fisheries or spawn-on-kelp products.

Keywords: Pacific herring, *Clupea pallasii,* Southeast Alaska, spawning populations, dive surveys, stock assessment, fishery

PURPOSE

The primary intents of this report are to document data collected from fall 2021 through spring 2022 and to provide historical perspective by presenting general trends in Southeast Alaska herring populations.

The data presented in this report include the principal inputs for models that are used to forecast mature herring biomass and age compositions for the ensuing year. Per regulations, biomass forecasts are compared to stock-specific threshold biomass levels to determine whether a fishery will be allowed in a particular area. Biomass forecasts are coupled with appropriate exploitation rates (maximum of 20%) to determine the allowable harvest levels, and allocations for commercial quotas for each fishery are determined by the appropriate regulations and management plans.

INTRODUCTION

Pacific herring *Clupea pallasii* have been the target of commercial fisheries in Alaska since 1878, with harvests growing to multi-million pounds annually by 1882 (Cobb 1905). As fisheries developed, the desire for better knowledge and understanding of herring populations grew, leading to the initiation of research programs. Initially, studies were focused on observations made from trends in commercial catch, especially during the height of the large-scale reduction fishery that peaked in 1930. As questions arose about the cause of fluctuations in catch, the lack of herring availability, and the impact of commercial fishing on herring, and as fishery science theory developed worldwide, scientific techniques were applied to herring populations in Alaska. Quantitative, fishery-independent study of herring began in Alaska by the early 1930s, and research was carried out by the U.S. Department of Commerce, Bureau of Fisheries. Rounsefell and Dahlgren (1935) measured spawning levels by area and attempted to differentiate spawning populations in Southeast Alaska through analyzing vertebrae counts and growth rates and through tag–recapture studies. By the 1940s, the importance of age-class strength became recognized for monitoring and predicting herring abundance, and research was largely conducted by the U.S. Department of the Interior, Fish and Wildlife Service (USFWS). Estimates and forecasts of abundance and yield by age became mainstays of management during this time. By 1953, programs were in place for standardized, detailed collection of data from spawning grounds, including aerial surveys, measurements of spawn along shoreline, egg density, and egg mortality, which enabled estimation of spawning biomass (Grice and Wilimovsky 1957). The USFWS continued to lead herring research in Alaska after statehood in 1959, operating under a cooperative agreement with the State of Alaska during 1960 and 1961. However, in 1962 the cooperative agreement was discontinued, and herring spawn surveys conducted by USFWS were suspended. Starting in 1963 the Alaska Department of Fish and Game (ADF&G) began conducting aerial surveys in the Craig–Hydaburg and Sitka areas, which were later expanded to other important herring spawning areas.

ADF&G instituted a full research project in 1971 to evaluate herring stocks in Southeast Alaska. This project was developed in response to greater demands on the resource by the commercial bait and developing sac roe fisheries. The goal of the project was to provide the biological data necessary for scientific-based fishery management of the region's herring stocks.

A variety of survey techniques have been used in the past to assess herring stocks in Southeast Alaska, including aerial visual estimates, hydroacoustic surveys using vessels, and spawn deposition surveys using scuba gear. Data generated during these stock assessment surveys—along with data collected for age, weight, and length estimates—are used directly in the management of all commercial herring fisheries conducted in Southeast Alaska. Data are currently analyzed using 1 of 2 different stock assessment models used to estimate and to forecast mature herring abundance and biomass. These models include an integrated statistical catch-at-age model (historically called age-structured analysis, or ASA, model) and a biomass accounting model.

Since 1971 biomass estimates and abundance forecasts of mature herring in Southeast Alaska were based on either hydroacoustic surveys or the product of estimates of egg density and area of spawn deposition (called *spawn deposition* method). Currently, the ASA model is used for herring populations with longer (i.e., generally a minimum of 10 years) time series of stock assessment data, and the biomass accounting model may be used for all other stocks where fisheries occur or on occasions when time constraints prevent use of the ASA model. These 2 models are not mutually exclusive of the spawn deposition method. Spawn deposition data (i.e., total egg deposition estimates) are an important element of ASA and biomass accounting models. A primary difference between the 2 approaches is the number and type of data inputs required to conduct the respective analyses and the model outputs. Biomass estimates derived from the spawn deposition method use only the most recent spawn deposition data and do not factor in trends in age composition or weight-at-age. A conversion factor based on an estimate of the number of eggs per ton of herring is applied to the total egg estimate to compute spawning biomass. In contrast, the ASA model uses a time series of age compositions, weight-at-age, total egg deposition, and catch, along with fecundity relationships to estimate biomass; it produces estimates of mean survival, maturity, selectivity, and recruitment. Biomass accounting, which does not require a data time series, is based on spawn deposition estimates adjusted for natural mortality, age-specific growth, and recruitment, which are elements produced by the ASA model, usually from a nearby herring stock. A more detailed explanation of the ASA and biomass accounting models and how the objective estimates are used in these models are provided by Carlile et al. (1996).

Since 1993, when data has allowed, the ASA model has been used to estimate and forecast the abundance of herring for 4 major Southeast Alaska herring stocks: Sitka, Craig, Seymour Canal, and Revillagigedo Channel (also called *Revilla Channel*, which refers to the greater Kah Shakes–

Cat Island and Annette Island spawning areas). The ASA model has been used for Tenakee Inlet since 2000. For these 5 potential commercial harvest areas or spawning populations, the time series of data has been or had been sufficient to permit the use of ASA for hindcasting historical biomass and forecasting future biomass. Other areas, which may support significant herring fisheries but lack data time series suitable for ASA, are candidates for biomass accounting. This simpler modeling approach began in 1996 and has been used to generate forecasts for West Behm Canal, Ernest Sound, Hobart Bay–Port Houghton, and Hoonah Sound. Age-structured analysis and biomass accounting models are mentioned here to provide historical perspective and because they are important elements of the overall stock assessment of herring in Southeast Alaska. Although results from these models are not discussed in this report, the key data inputs for these models are presented.

METHODS AND PROCEDURES

AERIAL AND SKIFF SURVEYS

A combination of aerial and skiff surveys was used to record spawning activities during the spring, to document spawn timing, and to estimate the distance of shoreline that received herring spawn. These surveys focused on several historically important spawning areas (Figure 1) and several minor spawning areas in Southeast Alaska. Aerial surveys typically commenced prior to the historical first date of spawning for each stock. Historical spawning dates by stock are presented in Figures 2–11. In addition to documenting herring spawn and herring schools, estimates of numbers and locations of herring predators, such as birds, sea lions, and whales, were recorded. Once concentrations of predators were observed, aerial and skiff surveys were conducted more frequently (e.g., daily or sometimes multiple flights per day) to ensure accurate accounting of herring distribution and herring spawn. The shoreline where herring spawn (milt) was observed was documented on a paper chart or electronic handheld device during each survey and then later transferred to computer mapping software to measure shoreline distance that received spawn. A chart depicting the total unique shoreline where spawn was documented at any time during the duration of the spawning event was used as the basis for targeting and designing the spawn deposition dive surveys.

SPAWN DEPOSITION SURVEYS

Optimal timing of spawn deposition surveys is about 10 days after the first significant spawning day of the season in each spawning area. This delay usually allows adequate time for herring to complete spawning and marine mammals to leave the area while minimizing the time eggs are subjected to predation or wave action that may remove eggs from the spawning area. To account for egg loss from the study site prior to the survey, a 10% correction factor is applied to inflate the estimate of total egg deposition. This value is an estimate based on several studies that have been conducted to estimate herring egg loss from deposition areas in British Columbia (for example, see Schweigert and Haegele [2001]; Haegele [1993a–b]) and in Prince William Sound. These studies found that the extent of egg loss due to predation and physical environmental stress depends upon several things, including length of time since deposition, depth, and kelp type. Historically, a correction factor based on 10% egg loss prior to survey has been used in Southeast Alaska, British Columbia, and Prince William Sound. Although this factor continues to be used in Alaska for time series consistency, more recent studies suggest that 25–35% egg loss may be more accurate. Because length of time since egg deposition is a key factor contributing to egg loss, a serious attempt has been made to conduct surveys within 10 days; however, at times surveys were delayed to balance survey scheduling for simultaneous spawning events or to accommodate availability of survey participants. Surveys conducted substantially after the 10-day period tend to result in underestimates of egg deposition and mature biomass. Historical dates of spawn deposition surveys are presented in Table 1.

Shoreline Measurement and Transect Orientation

Spawn documented during aerial surveys was transcribed in ArcMap (version 10.3) over raster images of nautical charts published by the National Oceanic and Atmospheric Administration, using the NAD 1983 datum and State Plane Alaska FIPS 5001 (ft) Projected Coordinate System. Spawn was drawn to conform to the shoreline so that any given segment of shoreline that received spawn had an approximately equal chance of being sampled during the dive survey. This process required a tradeoff so that shoreline features could be smoothed without adhering too closely to the shore on a small scale, but also without drawing straight lines that did not adequately capture enough detail to design a meaningful survey.

Shoreline measurement—and consequently transect placement—can be subjective at times, depending on the location of spawn deposition relative to the shoreline, bottom contour and depth, and map resolution. Fine measurement of a convoluted shoreline may substantially increase measurements of spawn but may not be appropriate for instances when spawn deposition does not closely follow the shoreline. In such situations, less resolution is used for measurements and transects are placed perpendicular to a theoretical shoreline, so they intersect the spawn in a meaningful way to sample across the spawn zone. Conversely, spawn may closely follow a convoluted shoreline, requiring finer resolution of measurements; in this situation, transects are placed perpendicular to the actual shoreline contingent upon physical features such as depth, bottom slope, and distance to the opposite shore. For example, a steeply sloped shoreline with a narrow band of spawn habitat (e.g., typical of Sitka Sound) requires much finer shoreline mapping as opposed to an area with a broad gentle slope (e.g., Craig) interspersed with rocks and reefs at some distance from shore.

Another consideration is that the termination of transects while still in the egg zone may be necessary if spawn is present on the opposing shoreline. Transects are halted at the midpoint of opposing shoreline to prevent oversampling areas where a potential transect might have been placed. Similarly, transects that are surveyed within small coves are terminated at a central convergence point where other potential transects would intersect. Transects are terminated for these 2 situations to minimize bias due to unequal sampling probability of the spawn zone, although it is unlikely that bias would be eliminated without further corrections (Li et al. 2011). A theoretical example of a spawn line drawn along the shore, and how the layout of potential transects are considered for these instances, is presented in Figure 12.

The same procedure and patterns of drawing spawn were followed in 2022 as in past years; however, the process requires that judgment be used based on experience and knowledge of the local spawning areas. The intent of drawing a smoothed spawn line is to produce a survey area that is oriented along the spawn. Transects laid perpendicularly to the spawn line will sample egg density throughout the entire width of the spawn, while minimizing bias to the estimated egg abundance. A second objective of measuring the spawn observed along shorelines is to obtain an estimate of spawn length, which factors into the estimate of overall spawn area, and is discussed more below. For the Sitka Sound and Craig areas, standardized baseline representations of herring spawn shoreline have been developed and were used for analyses presented here. These baseline maps provide a predetermined line for drawing spawn in the current year that is consistent with prior years. The baseline maps were developed using documented historical spawn and local knowledge of the area to produce what was deemed the most sensible representation of shoreline for repeated use in herring aerial surveys and spawn deposition surveys.

Once the spawn shoreline was established, a single linear measurement of the shoreline was made using XTools Pro, a measuring tool extension used within ArcMap. The shoreline was divided evenly into 0.10 nautical mile segments, which were then randomly selected for transect placement. Therefore, transects were placed no closer together than 0.10 nmi, which was done to prevent adjacent transects from unintentional crossing due to slight errors in compass bearing or while navigating underwater.

Sample Size

The number of transects selected was proportional to the linear distance of spawn and followed, at a minimum, the average of suggested sampling rates listed in Table 2. Sampling rates in Table 2 were estimated using data from previous surveys. The statistical objective of the spawn deposition sampling was to estimate herring egg densities (per quadrate) such that the lower bound of a 90% confidence interval was at least within 30% of the mean egg density estimate. This method would also support the objective of estimating the total egg deposition at a particular location with the specified precision. A one-sided confidence interval was used because there is more concern to avoid overestimating, rather than to avoid underestimating the densities of spawn deposition. The number of actual transects selected for a survey are frequently increased beyond the minimum suggested rate to increase transect spatial distribution, potentially reduce variance, and make efficient use of scheduled vessel time.

The minimum target number of transects is estimated as follows:

$$n = \frac{\left(S_b^2 - \frac{S_2^2}{\overline{M}} + \frac{S_2^2}{\overline{m}}\right)}{\left(\frac{x\overline{d}}{t_\alpha}\right)^2 + \frac{S_b^2}{N}}; \quad (1)$$

where

n	=	number of transects needed to achieve the specified precision;
S_b^2	=	estimated variance in egg density among transects;
S_2^2	=	estimated variance in egg density among quadrates within transects;
$\overline{M}$	=	estimated mean width of spawn;
$\overline{m}$	=	estimated mean number of 0.1 m quadrates per transect;
x	=	specified precision, expressed as a proportion (i.e.,, 0.3 = 30%);
$\overline{d}$	=	overall estimated mean egg density;
t_a	=	critical t value for a one-sided, 90% confidence interval; and
N	=	estimated total number of transects possible within the spawning area.

Field Sampling

Transect direction was determined by comparing the physical features of the actual dive location to a chart depicting the spawn along the shoreline and then setting a compass bearing perpendicular to the spawn shoreline. Transects began at the highest point of the beach where eggs were observed and continued down to the depth in the subtidal zone where no further egg deposition was observed—typically around 21 m (70 ft) of depth. The section of each transect that was above the waterline was surveyed by walking until reaching a depth in the water that required diving (usually about 2 feet), at which point diving commenced. All diving was conducted in compliance within limits and guidelines outlined in the ADF&G Dive Safety Manual (Hebert 2006). Normally, little if any herring egg deposition occurs deeper than 21 m, although occasionally eggs will occur to or even below 24 m (80 ft).

A 2-stage sampling design, similar to that of Schweigert et al. (1985), was used to estimate the density of herring eggs. The field sampling procedure entailed 2-person dive teams swimming along transects and recording visual estimates of the number of eggs within a 0.1 m^2 sampling frame placed on the bottom at 5-meter intervals. Eggs throughout the entire water column were included if they were within the dimensions of the frame. Situations where eggs were found on vertical canopy kelps such as *Macrocystis* spp. required divers to swim up along the length of the kelp to estimate eggs while maintaining reference to the sampling frame. To help estimate the number of eggs, estimators used the standard reference of 40,000 eggs per single layer of eggs within the sampling frame, which was determined mathematically using measurements of average egg diameter and frame dimensions. Additional data recorded included bottom substrate type (Appendix A), primary vegetation type upon which eggs were deposited (Appendix B), percent vegetation coverage within the sampling frame, and frame depth. Because sampling frames were spaced equidistant along transects, the record of the number of frames was also used to compute transect length.

VISUAL ESTIMATE CORRECTION

Because surveys rely on visual estimates rather than actual counts of eggs within the sampling frame, measurement error occurs. To minimize bias and the influence of measurement error on estimates of egg deposition within each frame, estimator-specific correction coefficients were applied to adjust egg estimates either up or down depending on an estimator's tendency to underestimate or overestimate. Correction coefficients were calculated by double sampling frames independent of those estimates obtained along regular spawn deposition transects (Jessen 1978). Samples for correction coefficients were collected by visually estimating the number of eggs within a 0.1 m^2 sampling frame and then collecting all the eggs within the frame for later more precise estimation in a laboratory. First, eggs on a variety of vegetations (e.g., algae, kelp, sea grass) were collected underwater and then while onboard a vessel assembled into a variety of sample sizes among vegetation categories. Approximately 10 samples for each of 5 vegetation categories were created, and attempts were made to create samples of varying egg density and varying total egg abundance within each vegetation type. Vegetation categories included eelgrass (ELG), fir kelp (FIR), large leafy brown kelp (LBK), rockweed (FUC), and hair kelp (HIR; see Appendix A1 for species included within each category). Next, divers placed individual samples within sampling frames that were longlined along a shallow depth contour of about 10 ft. Next, potential herring survey egg estimators (i.e., someone who may make herring egg estimates along transects if they are properly calibrated) dove along the longline, making estimates of each sample, recording estimates on sample labels, and placing them in a mesh bag attached to each sampling frame. To collect the samples after estimation, divers removed the vegetation (e.g., algae, kelp, sea grass) along with the eggs and preserved them in 100% salt brine solution in heavy grade plastic zip-sealing bags. Samples were transported to the ADF&G Mark, Tag and Age Laboratory in Juneau, where analysis was conducted within the following few months. Lab estimates were made for each sample by stripping eggs from vegetation, counting the number of eggs within 2 or 3 subsamples (typically about 1,000 eggs each), and then measuring the volumes of subsamples and full samples to calculate total eggs by proportion.

Correction coefficients were calculated as the ratio of sums of all laboratory estimates to all visual estimates, within each kelp type, for each estimator. To reduce potential of highly variable correction coefficients, minimum sample size guidelines were used. Data from the last 3 years were pooled if there were at least a total of 6 samples for each estimator and kelp type, with at least 3 samples in at least 2 of the 3 years. If this was not satisfied, then samples from prior years were added until the minimum sampling guideline was met. The intent of these sampling guidelines was to achieve a reasonably adequate sample size to minimize variation, but also to develop correction coefficients that reflected an estimator's tendency to estimate high or low in the most recent years.

Vegetation-specific estimator correction coefficients were applied to egg estimates when the appropriate vegetation type matched. For example, the *large leafy brown kelp* correction coefficient was applied when kelp types that fit that description were encountered, and the *eelgrass* correction coefficient was applied when eelgrass was encountered. When eggs were encountered that were loose in the water column, were adhering to bare rock, or were on vegetation types that were not like the categories sampled for calibration of egg estimates, an estimator-specific correction coefficient based on the average of all vegetation-specific estimator correction coefficients was applied.

ESTIMATES OF TOTAL EGG DEPOSITION

Total egg deposition for each spawning area (t_i) was estimated as follows:

$$t_i = a_i \bar{d}_i, \qquad (2)$$

where a_i is the estimated total area (m^2) on which eggs have been deposited; and $\bar{d}_i$ is the estimated mean density of eggs per 0.1 m^2 quadrate, extrapolated to 1 m^2 area ($eggs/m^2$) at spawning area i. The total area on which eggs have been deposited (a_i) is then estimated as

$$a_i = l_i \bar{w}_i, \qquad (3)$$

where l_i is the total length of shoreline (m) that received spawn (determined from aerial and skiff surveys); and w_i is the mean width of spawn (m), as determined by the mean length of transects conducted at spawning area i.

The mean egg density ($eggs/m^2$) at area i ($\bar{d}_i$) is calculated as

$$\bar{d}_i = 10 \cdot \left[\frac{\sum_h \sum_j \sum_k v_{hijk} c_{hk}}{\sum_h m_{hi}} \right], \qquad (4)$$

where v_{hij} is the visual estimate of egg numbers by estimator h, at area i, quadrate j, on vegetation type k. The c_{hk} term refers to a diver-specific, vegetation-specific correction coefficient to adjust visual estimates made by estimator h on vegetation type k; m_{hi} is the number of quadrates visually estimated by estimator h at area i. Because egg estimates are made within 0.1 m quadrates, multiplying by 10 expresses the mean density in per 1.0 m^2. Vegetation-specific estimator correction coefficients (c_{hk}) are calculated as follows:

$$c_{hk} = \frac{r_{hk}}{q_{hk}}, \tag{5}$$

where r_{hk} is the sum of laboratory estimates of eggs collected from quadrates that were visually estimated by estimator h on vegetation type k, and q_{hk} is the sum of visual estimates of eggs for estimator h on vegetation type k.

SPAWNING BIOMASS ESTIMATION

The total number of eggs per spawning area is a key element in assessing and forecasting herring spawning biomass. Although spawning biomass calculated directly from egg deposition is not an input for the SCAA or biomass accounting models, like total egg deposition estimates, it does provide a useful rough estimate of biomass each year. These values can be useful for comparison among years to track general trends in abundance, and they are intuitive in that the estimates do not change with subsequent years of data. Conversely, SCAA-derived hindcasted estimates change with each model run as new data is added.

The conversion of eggs to spawning biomass is calculated using a stock-specific fecundity-to-weight relationship for the areas where fecundity estimates are available (Sitka Sound, Seymour Canal, Craig, Kah Shakes–Cat Island. For all other stocks, the fecundity-to-weight relationship is calculated from the closest spawning stock where fecundity estimates are available (Table 3). The estimate for each area is calculated as follows:

$$b = h_{\bar{g}} * \bar{g}, \tag{6}$$

where

b = estimated total spawning biomass;

$h_{\bar{g}}$ = number of fish of mean weight in the area; and

$\bar{g}$ = mean weight of fish for each area, weighted by age composition.

The number of fish of mean weight ($h_{\bar{g}}$) is calculated as follows:

$$h_{\bar{g}} = \frac{\left(\frac{t}{L}\right) * 2}{f_{\bar{g}}}, \tag{7}$$

where

L = egg loss correction factor (0.9), which accounts for an estimated 10% egg mortality between the time eggs are deposited and spawn deposition surveys are conducted; and

$f_{\bar{g}}$ = estimated fecundity of fish of mean weight, using equations listed in Table 3.

AGE AND SIZE

Herring samples were collected from several stocks or spawning areas located throughout Southeast Alaska using a combination of skiff spawn surveys, aerial spawn surveys, commercial fisheries, and test fisheries (when prosecuted). Sample collection gear varied with location and historically has included purse seines, gillnets, cast nets, or trawls. Cast nets were used when fish were in shallow water during active spawning. Herring sampled from commercial fisheries were collected from individual harvesters or tenders while on the fishing grounds. Dates, gear used, and geographic locations of all samples were recorded.

Based on multinomial sampling theory (Thompson 1987), a sample size of 511 ages is considered sufficient to provide age composition estimates that deviate no more than 5% (absolute basis) from the true value, with an alpha level of 0.10 (i.e., the chance of rejecting a true value is about 10 percent). The minimum sampling goal was set at 525 fish to ensure that at least 500 readable scales would be obtained for aging from each commercial fishery (i.e., purse seine or gillnet samples) and each spawning stock (i.e., cast net samples).

All samples were packaged and labeled in 5-gallon buckets and frozen for later processing at the ADF&G Mark, Tag and Aging Laboratory in Juneau, Alaska. After thawing samples in the laboratory, the standard length (mm) of each fish (tip of snout to posterior margin of the hypural plate) was measured. Fish were weighed on an electronic balance to the nearest 10th of a gram.

A scale was removed from each fish for age determination. The preferred location is on the left side anterior to the dorsal fin or beneath the left pectoral fin. Scales were cleaned and dipped in a solution of 10% mucilage and placed unsculptured side down on glass slides. Aging was conducted by viewing scale images on a microfiche projector to count annuli. Age data for early years (1980–1998) were obtained by viewing scales through a dissecting microscope, varying the light source for optimum image of the annuli. From 1999 to present, ages have been determined by mounting scales on a microfiche reader to project a larger scale image to see annuli more easily. Each fish was assigned an anniversary date for each completed growing season. Samples were generally collected before growth resumed in the spring, and scales were aged based on the number of summer growth periods observed. For example, if a herring hatched in the spring of 2011 and was collected in the fall of 2012, then 2 growing seasons had occurred (age-2). If the herring had been collected in the spring of 2013 before growth had resumed, it was also recorded as age-2. Occasionally spawning occurs late (e.g., June) when growth resumes, producing *plus growth* on scales, which is ignored because it does not represent a full growth period. Scales were spot-checked by a second reader for age verification, and if agreement between readers was less than 80%, the entire sample was re-aged.

Condition Factor

Condition factor (CF) was calculated to provide a general indication of overall condition of fish based on body proportion. Condition factor was based on the method described in Nash et al. (2006) and was estimated as follows:

$$CF = \left(\frac{w}{l^3}\right) * 100, \tag{8}$$

where

w	=	whole body wet weight in grams, and
l	=	standard length in millimeters.

Sea Temperature

Daily sea surface temperature was recorded in spawning areas for most stocks using Onset HOBO StowAway TidbiT temperature loggers that were submerged to depths ranging from about 10 ft mean lower low water (MLLW) to 20 ft MLLW. Temperature has been recorded daily at 6-hour intervals for up to 20 years in some spawning areas. Daily mean, minimum, and maximum sea temperature was calculated for each spawning area. Overall annual mean temperature was calculated as the mean of all daily values. Mean annual minimum temperatures and mean annual maximum temperatures were calculated as the mean of the minimum or maximum values that occurred during each annual cycle.

HARVEST STRATEGY

Allowable harvest levels for commercial herring fisheries in Southeast Alaska are set based on a harvest strategy that involves a graduated harvest rate paired with a minimum threshold of mature herring. When herring biomass is forecasted to be at or above threshold, a harvest rate of 10–20% is applied to the biomass forecast. For most herring stocks, the harvest rate may be set at 10% when the biomass forecast is at threshold up to a maximum of 20% when the forecast is 6 times the threshold or greater. In the Sitka Sound area, the harvest rate is set at 12% when the forecast is at threshold, and at a maximum of 20% when the forecast is twice the threshold or greater. Maximum harvest rates used for herring in Southeast Alaska are based on studies in Alaska and elsewhere that concluded a maximum 20% harvest rate is sufficiently conservative to maintain healthy stocks of herring when paired with appropriate thresholds (Zheng et al. 1993; Doubleday 1985). The sliding scale element of the harvest rate calculation used for Southeast Alaska herring was included as an additional precautionary measure to reduce the harvest rate as stock biomass declines toward the threshold.

Threshold biomass levels have been established for each commercially exploited stock in Southeast Alaska. These thresholds are intended to reduce the risk of sharp declines in abundance due to recruitment failure and to maintain adequate herring abundance for predators. Commercial harvest of herring is not permitted unless the forecast of mature herring meets or exceeds the threshold. For Sitka Sound and West Behm Canal, threshold levels were based on analyses using simulation models to estimate 25% of the average unfished biomass (Carlile 1998a, 2003). In the case of Sitka Sound, the threshold was subsequently increased by the Board of Fisheries on 2 occasions (1997 and 2009) to provide additional protection to the stock and to help alleviate concerns over adequate subsistence opportunities to harvest the resource. For the Tenakee Inlet stock, 25% of the average unfished biomass was estimated using the same methods; however, because the resulting value was lower than the 3,000-ton threshold that existed at that time, the existing threshold was retained as a precaution (Carlile 1998b). For all other stocks in Southeast Alaska, thresholds were established using a less quantitative approach, which entailed reviewing historical estimates of abundance, historical knowledge of stock size fluctuation and distribution, and manageability of minimum quotas. Threshold levels during the 2021–2022 season ranged from 2,000 tons (Hoonah Sound and Hobart Bay) to 25,000 tons (Sitka Sound).

Management Plan

The following management plan was in place for the 2021–2022 Southeast Alaska commercial herring fisheries. It was adopted by the Alaska Board of Fisheries at its January 1994 meeting.

5 AAC 27.190. Herring Management Plan for Southeastern Alaska Area. For the management of herring fisheries in the Southeastern Alaska Area, the department

(1) shall identify stocks of herring on a spawning area basis;

(2) shall establish minimum spawning biomass thresholds below which fishing will not be allowed;

(3) shall assess the abundance of mature herring for each stock before allowing fishing to occur;

(4) except as provided elsewhere, may allow a harvest of herring at an exploitation rate between 10 percent and 20 percent of the estimated spawning biomass when that biomass is above the minimum threshold level;

(5) may identify and consider sources of mortality in setting harvest guidelines;

(6) by emergency order, may modify fishing periods to minimize incidental mortalities during commercial fisheries.

Additionally, the following regulation was in effect to set harvest levels in Sitka Sound:

5 AAC 27.160 Quotas and guideline harvest levels for Southeastern Alaska Area.

(g) The guideline harvest level for the herring sac roe fishery in Sections 13-A and 13-B shall be established by the department and will be a harvest rate percentage that is not less than 12 percent, not more than 20 percent, and within that range shall be determined by the following formula:

$$\text{Harvest Rate Percentage} = 2 + 8\left[\frac{\text{Spawning Biomass (in tons)}}{20{,}000}\right]$$

The fishery will not be conducted if the spawning biomass is less than 25,000 tons.

Although there are several other regulations within the Alaska Administrative Code that pertain to specific herring fisheries in Southeast Alaska, the above general management plan represents the overarching requirements for setting harvest levels for herring fisheries in the region.

RESULTS

AERIAL AND SKIFF SURVEYS

Aerial and skiff surveys of herring activity, herring spawn, and marine mammal and bird activity were conducted at major stock locations. These surveys began on March 9, 2022, in Sitka Sound and ended on June 2, 2022, in Seymour Canal. Notes of activity related to herring or herring spawning were recorded in aerial survey logs (see Appendix C). Surveys or observations were conducted by staff from each area office (Ketchikan, Petersburg, Sitka, Juneau, Haines, and Yakutat) and covered important or traditional herring spawning locations within each management area. Occasionally, private pilots or local residents may report observations of active spawning. Spawning timing for each monitored spawning area is summarized in Figure 13—including dates of first, last, and major spawning events. ADF&G also completed aerial surveys of Annette Island Reserve while en route to other spawning areas located in state waters.

The total documented spawn for major spawning areas in state waters where aerial surveys were conducted in Southeast Alaska and Yakutat in 2022 was 146.3 nmi. This measurement did not include spawning around Annette Island Reserve, or numerous minor spawning areas in Southeast Alaska or Yakutat (see Appendix C for a detailed accounting of other minor spawn areas throughout Southeast Alaska). The highest levels of spawn were observed in the Sitka Sound area (91.5 nmi) and in the Craig area (36.4 nmi). Spawning observed in other survey areas ranged from 0 nmi in Hoonah Sound to 6.6 nmi in Kah Shakes–Cat Island (i.e., Revilla Channel).

SPAWN DEPOSITION SURVEYS

During spring 2022, spawn deposition dive surveys were conducted only in Sitka Sound, Craig, and Revilla Channel. The first survey was conducted April 9 in the Revilla Channel area, followed by the Sitka Sound area during April 13–16, and finishing in Craig during April 17-18 (Table 1). Egg estimates by transect for each spawning area are presented in Table 4.

Due to a combination of low levels of observed spawning and budget reductions, spawn deposition surveys were not conducted in 2022 in several historically surveyed areas, including Seymour Canal, Tenakee Inlet, Lynn Canal, Hoonah Sound, West Behm Canal, Ernest Sound, or Hobart Bay–Port Houghton. These areas are considered *inside* stocks (i.e., less exposed to open ocean as Sitka and Craig, which are considered *outside* stocks) and for several years have persisted at low levels based on observed spawn mileage levels. Aerial surveys were made opportunistically in several additional minor spawning areas, but low observed spawning again indicated dive deposition surveys were not warranted. In some minor areas specifically (e.g., Bradfield Canal), surveys conducted in previous years revealed that despite substantial miles of observed spawn only a narrow band of spawning habitat existed, resulting in relatively low egg deposition and therefore lessening justification for egg deposition surveys (see Appendix C).

In the Sitka Sound and Craig areas, egg deposition estimates in 2022 were substantially lower than those from 2021, though still respectively the 4th and 3rd highest on record. In Sitka Sound, a decrease from 27.3 trillion eggs to 14.6 trillion eggs was due primarily to a substantial decrease in egg density, which declined from 1,426,809 eggs/m^2 in 2021 to 813,231 eggs/m^2 in 2022. In Craig, the egg deposition estimate declined from 8.4 trillion to 5.3 trillion eggs, which was also attributable to a large decrease in egg density, from 1,447,064 eggs/m^2 in 2021 to 817,542 eggs/m^2. Despite the decline, the egg density estimate for Craig in 2022 was one of the highest on record. For Sitka and Craig, the estimated spawning biomass in 2022 differed from 2021 in similar proportion to egg estimates. A summary of the 2022 survey results, including spawn mileage, average transect length, area of egg deposition, egg density, estimated egg deposition, and estimated spawning biomass is presented in Table 5. For comparison of 2022 spawning stock abundance to prior years, estimates of historical spawning biomass for both inside and outside stocks are presented in Figures 14–19.

Visual Estimate Correction

Minimum sample size guidelines (at least 6 samples per vegetation type for 2 of the last 3 years) were met using data from 2020 through 2022 for all estimators. Correction coefficients applied to 2022 spawn deposition visual estimates ranged from 0.46 to 1.36 and are presented in Table 6.

Visual review of observed versus laboratory estimates of eggs suggests the presence of linear relationships for some estimators, but nonlinear relationships for others. These nonlinear patterns are caused by an innate tendency to underestimate when egg numbers in sample frames are high. A similar nonlinear pattern has been observed for aerial estimates of salmon in streams (see Jones et al. 1998); however, correction coefficients in that study were also calculated as straight ratios of known to estimated values. For herring egg correction coefficients presented here, values were calculated as an overall ratio of values summed across the entire range of lab-estimated and visually estimated values, which was considered to adequately correct visual estimates. However, because nonlinear relationships probably exist that bias correction coefficients low, the result is that estimates of egg abundance are also probably biased low.

AGE AND SIZE

A combined total of 6,219 herring were sampled from all stocks and gear types (cast net, purse seine, and pound) during the 2021–2022 season. Of those, 5,954 herring were processed to determine age, weight, length, and sex, for those herring age-3 or greater. The reduction of sample size was due to exclusion of age-1 and age-2 herring, fish that could not be aged due to regenerated scales, or due to data that was otherwise unusable.

Samples of the spawning areas in Craig, Sitka Sound, Revilla Channel, Seymour Canal, Hobart Bay–Port Houghton, Ernest Sound, and Northern Stephen's Passage were taken using cast nets. Samples from Craig and Sitka Sound were collected throughout the geographic extent of the active spawn (Figures 20–21), and throughout the duration of spawning (Figure 13), focusing on the most intense spawning events when feasible. All other spawning areas were sampled more sporadically, as weather and time permitted, and may not have captured the full spatial or temporal range of spawning (Figures 22–25).

Samples were also obtained from all commercial fisheries that were conducted in 2021–2022. Fisheries sampled included Sitka Sound sac roe, Craig winter bait, and Craig spawn on kelp. Samples were obtained opportunistically from vessels or tenders during, or shortly after, the fishery openings. Sample locations during fisheries are shown in Figures 20–21.

The minimum sample goal of 500 aged fish per sampling event (gear–fishery combination) was exceeded for most areas and fisheries where samples were obtained. The goal was not achieved for Ernest Sound or Hobart Bay–Port Houghton (Table 7). Although age and size samples were not obtained for several other traditionally sampled stocks, aerial surveys were completed and observed spawn locations are presented for those stocks in Figures 26–29.

Age Composition

In 2022, age composition data were obtained for 7 spawning areas in the region: Sitka Sound, Craig, Revilla Channel, Seymour Canal, Hobart Bay-Port Houghton, Ernest Sound, and Northern Stephen's Passage. Samples were not obtained from Tenakee Inlet, Lynn Canal, Hoonah Sound, or West Behm Canal due to reduced funding, low levels of observed spawn, or inability to sample due to weather or other circumstances. Frequency distributions of herring ages from sampled spawning areas are presented in Tables 8–14 and Figures 30–33.

Observed age distributions for most sampled areas were similar in that age-6 herring dominated the spawning populations. Two exceptions were Kah Shakes–Cat Island and Ernest Sound, where the highest observed proportion was age-4 herring. The proportions of age-6 herring for these 2 areas were 32% in Revilla Channel and 23% in Craig. For all other areas sampled, the proportion of age-6 herring in 2022 ranged from 60% to 72%. The similar age compositions of spawning areas in Southeast Alaska, and the dominant age-6 class, are a result of the extremely strong 2016 cohort, first observed in 2019 as a very high proportion of age-3 recruitment. For perspective, historical age compositions of spawning populations are presented in Figures 34–43.

Based on observed proportions of age-3 herring, recruitment in 2022 appears to have been low to moderate. In 2022, age-3 proportions observed in sampled spawning populations ranged 4–31%.

The proportions of age-3 herring entering the mature population each year fluctuates in a similar, cyclical pattern among stocks in the region, with high and low years synchronized in many instances in magnitude, trajectory, or both (Figure 44). When northern and southern stocks are considered separately, the synchronized pattern is even more apparent within each group. For example, in 2015 a high proportion of age-3 herring was observed for all stocks; however, in 2016 a relatively low to moderate proportion of mature age-3 herring were observed in most spawning areas. It appears that age-3 proportions for spawning areas in 2022 were generally on par with those observed in 2021.

Size-at-age

Based on cast net samples in 2022, there remains a clear distinction between mean weight-at-age for Sitka Sound and other spawning stocks of herring in Southeast Alaska (Figure 45). Sitka Sound herring attained a higher average weight than other stocks by age 4, and the divergence increased with each age group.

Mean length-at-age among spawning areas has a similar pattern to weight-at-age. Although the distinction between Sitka Sound herring mean length-at-age and other Southeast Alaska stocks is visually apparent, it is not as great as observed for mean weight-at-age (Figure 46).

Trends in weight-at-age over time are variable among stocks (Figures 47–56). For most stocks, a common pattern is evident: weights of age-3 herring have been relatively stable over the past few decades, whereas those of older ages appear to have gradually declined. The decline appears to be more pronounced for the oldest age classes. The current range of mean weight among age classes appears narrower than it was 3 decades ago. Although the mean weight-at-age of herring is less now than it was 30 years ago, weight generally declined during the late 1980s to the early to mid-2000s but then appears to have stabilized over the past 15 years for most stocks. The exception is Sitka Sound, where weight-at-age appears to have remained relatively stable over the past 20 years; however, this followed a period of low weight-at-age in the early 1990s, a time when anecdotally herring had been described as *pencil herring*. Data presented here only date back to the late 1980s, which coincided with the period of low weight and low condition factor of Sitka area herring.

To understand whether changes in weight-at-age are due solely to body mass—or if changes in length-at-age play a role—it is helpful to calculate condition factors. Condition factors have been calculated to roughly gauge herring health using the physical dimensions of herring (i.e., weight-to-length ratio) over time (Figures 57–66). Because there is more complete and consistent data for cast net samples than commercial samples, data obtained from cast net samples during active spawn events were used to calculate condition factors. Weight estimates derived from samples of actively spawning herring probably produce lower average values that contain more variability than would be expected from pre-spawning fish sampled during the commercial fishery; however, the overall trends in condition factor are expected to be the same. Another benefit of using data from cast net samples is that bias is expected to be lower than for fishery-dependent data that may be influenced by selection of larger fish.

Mean condition factors of herring from most stocks in Southeast Alaska follow the same general pattern over the last two decades: relatively low in the early 1990s and peaking in the early 2000s, followed by a decline until about 2007. Starting in 2008, condition factors for most stocks increased sharply, peaking in 2010 and then declined sharply to 2012. The condition factors calculated for 2022 for stocks where data were available are relatively high and indicate a continued increase over the past few years.

Commercial Fisheries

Commercial harvest is permitted in an area only if the forecasted spawning biomass meets or exceeds a minimum threshold (Table 15). If that threshold is met or exceeded, then a sliding-scale harvest rate of between 10 and 20 percent of the forecasted spawning biomass is calculated to determine the appropriate harvest level. For Sitka Sound, the allowable harvest rate ranges from 12 to 20 percent of the forecasted spawning biomass.

During the 2021–2022 fishing season, only 3 commercial herring fisheries were conducted in Southeast Alaska. These fisheries took place in 2 spawning areas, Sitka Sound and Craig. Products resulting from these fisheries included sac-roe, food and bait, and spawn on kelp. A summary of locations, harvest levels, and periods of harvest is presented in Table 16.

Sac Roe Fisheries

The only commercial sac roe fishery in 2022 was conducted in the Sitka Sound area. There were no sac roe fisheries announced for Seymour Canal, West Behm Canal, Hobart Bay–Port Houghton, or Kah Shakes–Cat Island areas, in most cases because estimates of spawning biomass and forecasts were not conducted, primarily due to low levels of observed spawn. Lynn Canal was historically a sac roe fishery area; however, the Board of Fisheries rescinded regulations allowing a fishery in that area at its January 2018 meeting in Sitka.

Sitka Sound

In Sitka Sound the 2022 forecast was the largest on record at 225,820 tons, and the guideline harvest level (GHL), also the largest on record, was set at 45,164 tons. The GHL was calculated based on the maximum allowable 20% of the age-structured analysis (ASA) forecasted biomass. No decrements were made to the GHL. This decision was a departure from the past 2 years, when GHLs were lowered to account for uncertainty surrounding the forecasted return of the large 2016 age-class. Decrements were not made in 2022 because after multiple years of observing that age-class, forecasts were more certain and reductions were unwarranted.

The fishery went on 2-hour notice on March 22, 2022, at 8:00am. Beginning with the first fishery opening on March 26, 2022, the fishery was opened for 15 consecutive days, closing on April 10, 2022. The landed catch totaled 25,090 tons, with an average mature roe percentage of 11.9%. This was the largest harvest in the history of the Sitka Sound sac-roe fishery and represented 56% of the GHL. Landings were made by 29 of the 47 active permit holders for the fishery.

Just prior to the onset of the sac roe fishery, on March 21, 2022, a vessel grounded in Neva Strait and spilled an estimated 5,300 gallons of diesel fuel. The spill and sheen was monitored by the Alaska Department of Environmental Conservation (ADEC) and ADF&G staff worked closely with ADEC staff to assess potential impacts to the subsistence and commercial herring fisheries in the area. The sac roe fishery was not opened in areas where the sheen was observed or in proximity to a sheen if deemed to impact the quality of the harvest.

Seymour Canal

There was no commercial fishery in the Seymour Canal area during the 2021–2022 season, because no stock assessment survey or forecast was conducted due to low levels of observed spawn.

West Behm Canal

There was no commercial fishery in the West Behm Canal area during the 2021–2022 season, because no stock assessment survey or forecast was conducted due to low levels of observed spawn.

Hobart Bay–Port Houghton

There was no commercial fishery in the Hobart Bay–Port Houghton area during the 2021–2022 season, because no stock assessment survey or forecast was conducted due to low levels of observed spawn.

Kah Shakes–Cat Island

There was no commercial fishery in the Kah Shakes–Cat Island area during the 2021–2022 season. A stock assessment survey was conducted; however, results suggested that the biomass would be forecast below threshold and therefore a forecast was not conducted.

Winter Bait Fisheries

During the 2021–2022 season, the only winter food and bait fishery was in the Craig area. All other winter bait areas were closed due to low levels of observed spawn.

Craig

The fishery was opened in the Craig area on October 1, 2021, and was closed by regulation on February 28, 2022. The bait allocation was 7,590 tons, which was by regulation 60% of the total GHL of 12,650 tons. A total of 398 tons of herring were harvested.

Ernest Sound

There was no commercial fishery in Ernest Sound during the 2021–2022 season due to low levels of observed spawn and reduced funding.

Tenakee Inlet

There was no commercial fishery in Tenakee Inlet during the 2021–2022 season due to low levels of observed spawn and reduced funding.

Spawn-on-Kelp Pound Fisheries

In the spawn-on-kelp (SOK) fisheries, closed-pound fishing involves capturing sexually mature herring and releasing them into a net impoundment within which kelp is suspended. The herring are released from the pound after they spawn on the kelp and the kelp with eggs is then sold. Open-pound fishing involves suspending kelp from a floating frame structure in an area where herring are spawning. The herring are not impounded but instead they naturally spawn on the suspended kelp. The kelp blades with eggs are removed from the water then sold. In the Southeast Alaska herring SOK fisheries, a closed or an open pound may be operated by one or more Commercial Fisheries Entry Commission (CFEC) permit holders (Coonradt et al. 2017).

These fisheries present unique challenges to fishery management, primarily because herring are released alive after spawning in pounds, which makes determining herring usage and mortality difficult. Attempts have been made to estimate the amount of herring placed into pounds by brailing and weighing herring from pounds instead of releasing after spawning; however, these were largely unsuccessful due to low sample size of pounds and uncertainty about herring loss (e.g., to sea lion or eagle predation) prior to brailing. Estimates of herring use in SOK pounds have been completed in Prince William Sound (PWS) by measuring egg deposition on kelp and pound webbing, egg retention within herring, and herring fecundity to back calculate the number of herring (Morstad and Baker 1995; Morstad et al. 1992). These studies found that approximately 12.5 tons of herring are used for each ton of spawn-on-kelp product. Because mean pound size in PWS fisheries is substantially larger than those used in Southeast Alaska fisheries, this ratio may not be directly comparable. Nevertheless, because no studies have been completed in Southeast Alaska, this conversion is used to approximate herring usage for Southeast Alaska pound fisheries, particularly when reporting estimates over time for comparability. Other estimates of the amount of herring in pounds have also been used, which are based on observations of fishery managers during fisheries. These estimates have ranged from 10 to 20 tons of herring per closed pound structure and have been used as inputs to stock assessment models. To estimate herring deadloss from pounds, a mortality rate of 75% is assumed for herring that are placed into pounds.

The only area open to the commercial harvest of SOK during the 2021–2022 season was Craig. The other SOK areas in the region, Hoonah Sound, Ernest Sound, and Tenakee Inlet, were not opened during the 2021–2022 season because surveys and forecasts were not conducted, primarily due to low levels of observed spawn in 2021.

Craig

A total of 60 closed pounds were actively fished, by a total of 119 permit holders. Of the 60 closed pounds, there were 5 single, 51 double, and 4 triple-permit pounds. No open pounds were fished. Total harvest was 193 tons of spawn on kelp.

Hoonah Sound

There was no commercial fishery in Hoonah Sound during the 2021–2022 season due to low level of observed spawn.

Ernest Sound

There was no commercial fishery in Ernest Sound during the 2021–2022 season due to low level of observed spawn.

Tenakee Inlet

There was no commercial fishery in Tenakee Inlet during the 2021–2022 season due to low level of observed spawn.

Bait Pound (Fresh Bait and Tray Pack) Fisheries

During the 2021–2022 season, 21 tons of herring were harvested for fresh bait pounds or tray-pack in Southeast Alaska. This harvest occurred in Sitka Sound.

Test Fisheries

There was 239 tons of herring test fishery harvest in Southeast Alaska during the 2021–2022, which took place in Sitka Sound and was landed as winter bait.

DISCUSSION

Annual spawn deposition surveys and sampling for age and size are the primary sources of fishery-independent data used to assess herring stocks in Southeast Alaska. These data are valuable inputs for the models used to estimate and forecast mature biomass. These estimates of biomass are used to measure against fishery threshold levels to determine if commercial fisheries will be allowed. Although these models typically provide the department's best estimates of biomass, age composition, and other outputs such as recruitment and mortality rates, egg deposition, age, and size data can also be used to roughly estimate these figures. The results of the survey and sampling data provide a simple preview of raw data and trends in herring populations prior to the modeled results.

Spawn Deposition

The combined observed spawning biomass estimated in 2022 for Sitka Sound and Craig, as converted from egg deposition estimates, was 243,822 tons. This estimate is about twice the mean biomass for all Southeast Alaska herring stocks combined and among the highest estimates of regional biomass since the department instituted a herring stock assessment program in 1971. The estimate for these two stocks is about 55% of the 446,454 tons estimated for 2021. In 2022 a survey was also conducted for the Kah Shakes–Cat Island (Revilla Channel) stock, which resulted in an estimate of an additional 3,026 tons. The Sitka Sound and Craig stocks typically account for about 80% of the spawning biomass in Southeast Alaska. Sitka Sound observed spawning biomass decreased by 48% in 2022 relative to 2021, and Craig decreased by 37%. Although error estimates surrounding the biomass estimates were not calculated for the 3 stocks surveyed this year, it is assumed that changes greater than 20% reflect biologically meaningful changes in the spawning population levels.

Spawn deposition estimates for 2022 suggest that combined herring spawning biomass in Southeast Alaska remains at a high level relative to the period 1980–2021, and among the highest levels during this reference period. This is true despite only surveying 3 stocks in 2022, because Sitka Sound and Craig historically have accounted for a large proportion of the region's biomass. The 2022 combined estimate of 247,099 tons for all 3 surveyed areas is a considerable drop from the 2021 estimate of 452,121 tons but is still about twice (107% of) the mean regional spawning biomass (1980–2021).

After a period of building in the late 1990s with a peak from 2008–2011, herring spawning biomass in Southeast Alaska began a period of decline, particularly for spawning stocks located in inside waters. Coincident with the decline were reductions to state budgets, which has prevented annual stock assessment surveys for most herring stocks in the region since 2016. Stock assessment surveys have continued uninterrupted for only the 2 largest stocks, Sitka Sound and Craig. Because of this narrow focus, firm conclusions cannot be made about broader herring biomass trends throughout the region. Limited aerial surveys have continued in most areas, which have provided some information about stock levels; however, miles of shoreline do not necessarily provide an accurate depiction of spawning biomass. Nonetheless, when considering spawn mileage alone in areas other than Sitka Sound and Craig, herring stocks in the region remain at low levels in 2022 relative to the past few decades. This pattern suggests that outer coastal stocks are faring far better than those with less exposure to open ocean influence. It is unknown why this pattern persists. Herring populations are known to fluctuate dramatically and are especially susceptible to environmental influences (e.g., Toresen 2001). There may be multiple underlying causes for the persistent low level of inside stocks since 2011. Contributing factors may include increasing populations of predatory marine mammals, such as humpback whales and Stellar sea lions (Muto et al. 2016; Fritz et al. 2016); varying levels of predatory fish or squid; or recent shifts in water temperatures, which could affect herring food sources, life history, spawn timing, and metabolism.

Of course, another contributing factor could be commercial fishing. Although commercial fishing has occurred during some years for some stocks, the similarity in declines between fished and unfished stocks suggests that there may be substantial environmental influence.

Although the decreases observed for spawning biomass over the past year are most likely due to actual changes in the herring population levels, there is also a chance that the changes are at least partly a function of estimate variation, or a combination of both. Because error estimates were not calculated for spawn deposition estimates, it is possible that the changes in biomass were due, at least in part, to estimate error.

Estimates of observed spawning biomass presented in this report are based primarily on egg deposition estimates (as opposed to model-derived results), and are presented here solely to provide a general, broad-brush view of trends in mature herring biomass. These estimates should not necessarily be considered the most accurate estimate of biomass in any given year. For all major herring stocks in Southeast Alaska, the results of ASA or biomass accounting models are considered to provide the most reliable estimates of spawning biomass and are the basis for forecasting herring abundance and setting harvest levels. A primary reason that the ASA model provides more reliable estimates is that it incorporates other sources of data, such as age composition. The ASA model also combines a long time series of data to estimate spawning biomass, whereas spawn deposition-derived estimates rely on only a single year of spawn deposition data. An advantage of using biomass estimates derived from spawn deposition is that they provide a time series of fixed historical values, as opposed to ASA hindcast estimates derived from single model runs, which may be less intuitive because they change with each model run. Additionally, in some years modeling may not be completed for some stocks due to inadequate data or a very low level of spawning, which may leave gaps in the time series of estimates. Because spawn deposition surveys are conducted annually, biomass estimates derived from egg deposition provide a consistent and comparable time series to gauge trends.

Age Composition

Age compositions of most sampled spawning areas in 2022 were dominated by age-6 herring, clearly showing the continued progression of the large recruitment pulse of age-3 herring that was first observed in 2019. This strong year class was also reported for herring populations in Kodiak and Prince William Sound, corroborating the high recruitment event observed throughout the Gulf of Alaska in 2019. Broad-scale large recruitments have been observed in the past when Sitka Sound and Prince William Sound displayed very similar recruitment patterns (Carls and Rice 2007); however, the remarkable similarity and magnitude observed from Kodiak to southern Southeast Alaska is indicative of an uncommonly strong year class, which has supported herring populations at high levels for the past several years.

The specific mechanism that caused this recruitment spike over such a large scale is uncertain, but it was probably linked to a common pattern in ocean temperature. This cohort was hatched in spring 2016, which was coincident with the tail end of an unusually warm water mass that circulated through the northern Pacific Ocean, commonly called *the blob* (Gentemann et al. 2017). Although speculation, it is possible that elevated sea temperatures from the blob helped produce marine conditions favorable to larval and juvenile herring survival in 2016, ultimately leading to a large recruitment 3 years later when those fish first entered the spawning population. This marine heatwave was well known to have widespread effects on other species and marine communities across the North Pacific, although the implications to populations and the ecosystem are not yet fully understood (Ferriss and Zador 2020).

The high proportions of mature age-6 herring observed in 2022 suggests that this cohort may continue to be a large component of populations as age-7 herring; however, this age-class is nearing the end of its dominance and spawning biomass may return to levels observed prior to 2019, without additional large recruitment events. This trend may already be apparent because egg deposition and spawning biomass observed in 2022 appears to have dropped substantially, compared to the large increases that were observed between 2019 and 2021. The proportion of age-3 herring observed in spawning populations in 2022 appeared to be low to moderate (similar to 2021), which could eventually lead to declining biomass unless there is higher recruitment in coming years.

For herring stocks sampled in 2022, estimates of age composition continued to follow patterns that are generally expected from tracking previous cohorts. The proportion of cohort sizes either grew or declined as a result of increases due to maturation or decreases due to natural mortality and no surprising or abrupt changes were observed in relative cohort strength (see Figures 34–43). These patterns also lend support to the assumption that the method of aging scales from 2022 samples was consistent with those methods used in prior years, which has been a concern in prior years (see Hebert 2012a and 2012b).

Patterns of age composition over time—particularly proportions of age-3 herring—are also evident among stock groups within the region, suggesting that similar marine conditions may be present among certain areas within the region (Figure 44). The proportion of mature age-3 herring within each stock appears to be related to the latitude of the spawning stock. There appear to be two broad areas within the region where the mean proportion of age-3 herring is similar. For stocks south of latitude 56 degrees (i.e., those in the lower half of the region: Craig, West Behm Canal, Ernest Sound, and Kah Shakes–Cat Island), the mean proportion of age-3 herring is relatively high, but for stocks at 57 degrees and northward (Sitka, Hobart Bay, Seymour Canal, Hoonah Sound, Tenakee Inlet, and Lynn Canal), the proportions are relatively low. The strength of the 2019 age-3 pulse apparently overrode the usual pattern seen among stocks on separate sides of the latitudinal split, further indicating that the influence seen across the Gulf of Alaska was exceptional.

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TABLES AND FIGURES

Table 1.–Historical dates of herring spawn deposition surveys in Southeast Alaska.

Year	Sitka	Craig	Ernest Sound	West Behm Canal	Revilla Channel	Hobart Bay	Seymour	Tenakee	Hoonah Sound	Lynn Canal
1976	5/1–6	—	—	—	4/13–24	—	—	—	—	—
1977	4/26–28	—	—	—	4/13–19	—	—	—	—	—
1978	4/18–21	—	—	—	4/10–11	—	5/14–16	—	—	5/2–4
1979	—	—	—	—	4/9–12	—	—	—	—	—
1980	—	—	—	—	4/7–11	—	5/15–16	—	—	5/13–15
1981	4/10–11	—	—	—	4/1–4	—	5/14–15	—	5/4	—
1982	4/13–22	—	—	—	4/4–18	—	5/24–25	—	—	—
1983	4/13–17, 29	—	—	—	4/5–11	—	5/9–11	—	—	5/6
1984	4/10–17	—	—	—	4/10–15	—	5/4	5/5–7	5/8	5/4
1985	*	*	*	*	*	*	*	*	*	*
1986	*	*	*	*	*	*	*	*	*	*
1987	*	*	*	*	*	*	*	*	*	*
1988	4/15–20	3/24–25	—	—	4/8–12	—	5/5–7	5/10–11	—	5/14
1989	4/10–16	4/7–9	—	—	–-	—	5/17–19	5/10–12	4/18–19	—
1990	4/15–18	4/14	—	—	3/29–4/12	—	5/7–10	5/5–6	5/20–23	—
1991	4/25–27	*	*	*	*	*	*	*	*	*
1992	4/23–26	3/30, 4/18–21	5/2	—	4/14–17	5/10–11	5/9–10	—	5/5	—
1993	4/10–13	4/8	4/29–30	4/25–26	4/22–24	5/5	5/10–11	5/7–8	5/6	—
1994	4/8–11	4/18–19	5/6	5/4–5	4/15–17	5/7–8	5/12, 19	—	4/29–30	—
1995	4/7–10	4/6	5/2–3	—	4/20–22	5/4–6	5/23–24	—	4/27–28	—
1996	3/29, 4/2–4, 23–24	4/17–18	5/1	4/21	4/19–20	5/10	5/16, 29	5/15–16	5/12–13	—
1997	4/7–9	4/22–23	—	4/29–5/1	4/16–17	5/9	5/12–13	5/10–11	5/6–8	—
1998	4/1–3	4/12–14	4/22–23	4/20, 22–23	4/9	4/29–30	5/2, 8–9	5/5–7	5/4–5	—
1999	4/7–9	4/10, 20	—	4/16–17	4/14–15	4/4–5	5/11–12	5/7–8	5/9	—
2000	4/4–6	4/13–14	4/25	4/17–18	4/16–17	5/11	5/12–13	5/3–4, 6	5/7	—
2001	4/9–10	4/18–19	4/24	4/21–22	4/20	5/11–12	5/21–22	5/8–9	5/6–7	—
2002	4/8–11	4/16–18	4/21	4/19–20	—	5/10–11	5/30–31	5/3–4, 6	5/7	—
2003	4/8–11, 22	4/13–14	4/27	4/24–26	—	5/8–9	5/10	5/7	5/5–6	—

-continued-

Table 1.–Page 2 of 2.

Year	Sitka	Craig	Ernest Sound	West Behm Canal	Revilla Channel	Hobart Bay	Seymour	Tenakee	Hoonah Sound	Lynn Canal
2004	4/15–19	4/8–9	4/11, 21	4/19–20	—	5/9–10	5/11–12	5/7–8	5/5	5/13
2005	4/9–12	4/17–19	5/4	4/21	—	5/9–10	5/10–11	5/7	5/5–6	5/18
2006	4/7–8	4/10–11	4/14–15	4/29	—	5/7	5/10	5/8	5/4–5	5/26
2007	4/13–16, 24	4/18–19	4/24–25	4/23, 5/4	—	5/22	5/21	5/5	5/7	5/25
2008	4/10–14	4/15–16	5/2–3	4/18	—	5/13	5/16	5/10	5/7–8	5/21
2009	4/18–20	4/15–16	4/23	4/21–22	—	5/14–15	5/13–14	5/8–9	5/6–7	5/11–12
2010	4/16–19	4/14–15	4/22	4/20	—	5/5–6	5/7–8	5/11	5/9–10	5/12–13
2011	4/18–20	4/14–15	4/24	4/23	—	5/8–9	5/9–10		5/5–6	—
2012	4/13–16	4/21–22	4/24	4/23	—	5/5	5/12–13	5/8	5/7	5/10–11
2013	4/8–12, 5/2–5	4/14–15	4/17	4/16	—	5/8	5/13–14	5/11	5/12	5/10
2014	4/7–11, 24–26	4/13	4/22	4/15	—	5/1	5/10	5/7	5/8	5/9
2015	4/10–13, 5/6–7	4/8	4/21–22	—	4/6	5/5	5/11	5/9	5/6	5/10
2016	4/1–3, 20–21	4/8–9	4/26–27	—	—	—	5/8	—	—	5/7
2017	4/12–14, 28	4/7–8	—	—	—	—	5/15	—	—	—
2018	4/8–11, 24–25	4/13–14	—	—	—	—	—	—	—	—
2019	4/12–15	4/9–10	—	—	4/6	—	—	—	—	—
2020	4/4–6, 8–9	4/13–14	—	—	4/11	—	—	—	—	—
2021	4/17–21	4/15–16	—	—	4/11–12	—	—	—	—	—
2022	4/13–16	4/17–18	—	—	4/9	—	—	—	—	—

Note: Dashes represent years without surveys and asterisks represent years where surveys were completed but records of dates are missing.

Table 2.–Transect minimum sampling rates used for 2022 herring spawn deposition surveys.

	Estimated target transects per nautical mile of spawn[a]			
Area	Based on 1994 analysis	Based on 1997 analysis	Based on 2000 analysis	Average
Sitka	0.2	0.6	0.3	0.4
West Behm Canal	–	0.4	1.7	1.1
Seymour Canal	2.8	2.4	1.2	2.1
Craig	0.8	3.1	1.3	1.7
Hobart/Houghton	4.5	1.7	3.6	3.3
Ernest Sound	1.9	5.0	3.5	3.5
Hoonah Sound	2.9	1.0	0.7	1.5
Tenakee Inlet	5.1	1.2	1.6	2.6
Average	2.6	1.9	1.7	2.1

Note: en dash indicates stock was not included in analysis.

[a] Values represent the number of transects that will produce a lower bound of the one-sided 90% confidence interval that is within 30% of the mean egg density.

Table 3.–Fecundity relationships used for estimating 2022 herring spawning biomass for stocks in Southeast Alaska.

Sampling year	Stock sampled	Fecundity equation	Stocks to which fecundity equation is applied
2005	Sitka Sound	fecundity = –3032.0 + 198.8*weight	Sitka, Tenakee Inlet, Hoonah Sound
1996	Seymour	fecundity = –1573.3 + 222.4*weight	Seymour, Hobart Bay–Port Houghton, Lynn Canal
1996	Craig	fecundity = –1092.3 + 210.5*weight	Craig
1996	Kah Shakes–Cat Is.	fecundity = –1310.0 + 202.1*weight	Ernest Sound, West Behm Canal

Table 4.– Herring egg estimates (in thousands) by transect for 2022 spawn deposition surveys conducted in Southeast Alaska. Frame counts are the number of quadrats estimated along each transect.

	Craig		Sitka Sound Kruzof stratum		Sitka Sound Eastern stratum		Revilla Channel	
Transect Number	Egg estimate	Frame count	Egg estimate	Frame count	Egg estimate	Frame count	Egg estimate	Frame count
1	6,752	37	524	11	2,815	26	0	1
2	2,380	32	685	10	2	5	0	1
3	182	5	595	35	1,377	12	0	1
4	422	12	2,044	45	3,191	6	249	14
5	548	9	3,452	92	0	1	0	1
6	270	2	5,968	49	3,140	17	33	11
7	1,377	21	14,050	159	261	6	104	9
8	88	6	803	17	1,613	38	197	18
9	295	6	0	1	700	20	356	15
10	279	7	9,086	133	535	20	606	14
11	817	11	3,842	59	2,570	9	2	2
12	1,137	18	3,434	71	101	6	518	38
13	63	2	8,463	87	2,844	23	0	1
14	2,687	21	3,963	70	1,578	15	691	21
15	165	6	5,255	40	2,066	23	363	29
16	2,333	24	–	–	1,000	18	361	20
17	142	7	–	–	1,018	15	34	9
18	2,746	57	–	–	4,667	13	83	25
19	0	1	–	–	1,321	17	623	8
20	315	8	–	–	0	1	3,247	36
21	3,792	23	–	–	0	1	–	–
22	1,836	32	–	–	421	7	–	–
23	0	5	–	–	2,796	20	–	–
24	1	6	–	–	0	1	–	–
25	3,071	25	–	–	203	10	–	–
26	5,533	37	–	–	114	7	–	–
27	5,153	60	–	–	7,139	22	–	–
28	2,707	17	–	–	734	15	–	–
29	1,449	22	–	–	16	2	–	–
30	1,178	12	–	–	1,369	19	–	–
31	530	15	–	–	453	15	–	–
32	448	7	–	–	285	19	–	–
33	75	5	–	–	2	1	–	–
34	105	19	–	–	319	29	–	–
35	669	29	–	–	0	1	–	–

Note: En dashes indicate no survey transects planned or completed.

Table 5.–Summary of results of herring spawn deposition surveys in Southeast Alaska for 2022.

Spawning stock	Number of transects completed	Average length of transects (m)	Observed spawn (nmi)	Area of survey (m^2)	Average egg density ($eggs/m^2$)	Total eggs in survey area (trillions)	Mean fish weight (g)[d]	Estimated fecundity of fish of mean weight	Estimated number of fish	Post-fishery mature biomass (tons)
Craig	35	87	36.4	5,836,022	817,542	5.301	92.8	18,452	574,592,512	58,809
Sitka Sound (total)	50	97	91.5	16,125,602	813,231	14.571	120.5	20,928	1,392,469,025	185,013
Kruzof stratum	15	293	10.9	5,914,732	707,221	4.648	–	–	–	–
Eastern stratum	35	66	67.3	8,190,602	970,663	8.834	–	–	–	–
post-survey[a]	–	66	16.6	2,020,267	485,332	1.089	–	–	–	–
Kah Shakes–Cat Is.	20	69	6.6	837,289	272,479	0.253	75.2	13,889	36,502,193	3,026
Seymour Canal[b]	–	–	1.4	–	–	–	–	–	–	–
Ernest Sound[b]	–	–	2.6	–	–	–	–	–	–	–
Hobart–Houghton[b]	–	–	3.0	–	–	–	–	–	–	–
Hoonah Sound[b,c]	–	–	0.0	–	–	–	–	–	–	–
Lynn Canal[b]	–	–	1.4	–	–	–	–	–	–	–
Tenakee Inlet[b]	–	–	0.2	–	–	–	–	–	–	–
West Behm Canal[b]	–	–	1.4	–	–	–	–	–	–	–
Yakutat Bay[b]	–	–	1.8	–	–	–	–	–	–	–
Total	105	–	143.6	22,798,914	–	20.126	–	–	2,003,563,730	246,849
Average	35	84	–	7,599,638	634,417	6.709	96.2	17,757	—	–

Note: En dashes indicate data not available due to lack of survey (no funding or little or no spawn observed), or a total/average is not appropriate.

[a] Not surveyed, but average transect length and 50% average egg density from Eastern Stratum survey were applied to estimate spawn area and egg deposition.

[b] No spawn deposition survey conducted due low observed mileage in traditional spawning areas and reduced funding.

[c] Very infrequent aerial surveys conducted, so spawning may have been present but not observed.

[d] Represents mean weight of fish (in grams) in spawning population, weighted by age composition.

Table 6.–Correction coefficients used for herring spawn deposition estimates in Southeast Alaska in 2022.

	Estimator[a]					
Kelp type	A	B	C	D	E	Average
Eelgrass	0.85	0.97	0.84	0.85	0.84	0.87
n =	30	30	30	30	30	30
Fucus	0.64	1.36	0.89	0.74	0.92	0.91
n =	30	30	29	30	30	30
Fir kelp	0.46	0.80	0.57	0.58	0.54	0.59
n =	30	30	30	30	30	30
Hair kelp	0.88	0.83	0.89	0.75	0.94	0.86
n =	31	31	31	31	31	31
Large brown kelp[b]	0.79	1.08	0.72	0.66	0.86	0.82
n =	26	27	27	27	27	27
Average[c]	0.73	1.01	0.78	0.72	0.82	0.81

[a] Estimator identity is withheld to prevent results from altering estimating patterns in future years.

[b] Values are applied to genera *Agarum*, *Alaria*, *Costaria*, *Cymethere*, *Laminara*, *Saccharina*, and *Macrocystis*.

[c] Values are applied to estimates of eggs that are loose, on rock, or on unclassified kelp types.

Table 7.–Summary herring samples aged for Southeast Alaska stocks in 2021–2022.

	Commercial fishery			Survey	Test fishery	
Stock	Herring gillnet	Pound	Purse seine	Cast net	Purse seine	Total
Craig	–	549	512	628	–	1,689
Ernest Sound	–	–	–	343	–	343
Hobart–Houghton	–	–	–	263	–	263
Hoonah Sound	–	–	–	–	–	–
Lynn Canal	–	–	–	–	–	–
Seymour Canal	–	–	–	599	–	599
Sitka Sound	–	–	775	1,144	–	1,919
Tenakee Inlet	–	–	–	–	–	–
West Behm Canal	–	–	–	–	–	–
Revilla Channel	–	–	–	535	–	535
North Stephen Pass.	–	–	–	606	–	606
Yakutat	–	–	–	–	–	–
Total	–	549	1,287	4,118	–	5,954

Note: En dashes indicate that no samples were collected due to lack of funding and/or observed spawning.

Table 8.–Summary of age, weight, and length for the Sitka Sound herring stock in 2021–2022.

Gear type, season	Parameter	Age category 3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	50	153	35	835	28	43	1,144
	Percent age composition	4%	13%	3%	73%	2%	4%	100%
	Average weight (g)	67.3	83.1	101.1	114.2	129.8	137.0	105.4
	Standard dev. Of weight (g)	14.9	14.5	15.3	20.0	25.6	25.3	19.3
	Average length (mm)	171	183	195	201	208	214	195
	Standard deviation length (mm)	9.7	9.0	7.5	9.2	8.5	8.9	8.8
Commercial purse seine, spring	Number of fish	32	105	25	577	20	16	775
	Percent age composition	4%	14%	3%	74%	3%	2%	100%
	Average weight (g)	77.8	91.8	111.5	126.4	148.4	147.5	117.2
	Standard dev. Of weight (g)	14.6	15.9	13.7	21.3	19.3	18.6	17.2
	Average length (mm)	174	184	196	200	211	210	196
	Standard deviation length (mm)	8.5	8.8	7.4	9.0	7.6	6.6	8.0

Table 9.–Summary of age, weight, and length for the Craig herring stock in 2021–2022.

		Age category						
Gear type, season	Parameter	3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	56	103	11	441	12	5	628
	Percent age composition	9%	16%	2%	70%	2%	1%	100%
	Average weight (g)	60.4	76.8	86.1	100.8	93.6	117.2	89.1
	Standard deviation weight (g)	11.2	14.4	12.4	21.9	27.0	7.9	15.8
	Average length (mm)	162	174	182	188	184	196	181
	Standard deviation length (mm)	8.5	8.5	5.2	10.0	12.5	4.5	8.2
Commercial pound, spring	Number of fish	40	67	15	413	9	5	549
	Percent age composition	7%	12%	3%	75%	2%	1%	100%
	Average weight (g)	61.7	78.9	92.1	99.4	108.8	117.6	93.1
	Standard deviation weight (g)	13.4	17.4	15.7	22.0	13.0	19.5	23.9
	Average length (mm)	164	177	182	189	194	203	185
	Standard deviation length (mm)	8.5	9.3	9.8	10.2	5.0	10.1	12.6
Commercial purse seine, winter	Number of fish	67	107	25	300	10	3	512
	Percent age composition	13%	21%	5%	59%	2%	1%	100%
	Average weight (g)	61.5	81.0	85.2	106.0	99.2	134.9	94.6
	Standard deviation weight (g)	13.9	15.8	15.4	21.9	22.0	14.8	17.3
	Average length (mm)	163	176	181	190	191	206	185
	Standard deviation length (mm)	10.2	10.0	9.8	10.8	9.7	8.7	9.9

Table 10.–Summary of age, weight, and length for the Seymour Canal herring stock in 2021–2022.

		Age category						
Gear type, season	Parameter	3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	185	18	6	362	25	3	599
	Percent age composition	31%	3%	1%	60%	4%	1%	100%
	Average weight (g)	37.8	53.6	50.9	61.5	66.9	99.2	61.6
	Standard deviation weight (g)	8.4	8.5	9.5	12.2	15.7	14.4	11.5
	Average length (mm)	139	158	155	163	167	191	162
	Standard deviation length (mm)	9.3	8.2	11.2	9.4	12.2	2.3	8.8

Table 11.–Summary of age, weight, and length for the Kah Shakes–Cat Island herring stock in 2021–2022.

		Age category						
Gear type, season	Parameter	3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	33	302	13	171	11	5	535
	Percent age composition	6%	56%	2%	32%	2%	1%	100%
	Average weight (g)	61.0	67.2	80.1	89.5	91.5	116.6	84.3
	Standard deviation weight (g)	13.8	12.4	19.2	16.8	14.7	17.7	15.8
	Average length (mm)	166	170	178	186	185	200	181
	Standard deviation length (mm)	9.8	8.6	12.3	9.7	8.8	8.7	9.6

Table 12.–Summary of age, weight, and length for the Hobart Bay/Port Houghton herring stock in 2021–2022.

		Age category						
Gear type, season	Parameter	3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	30	25	3	189	8	8	263
	Percent age composition	11%	10%	1%	72%	3%	3%	100%
	Average weight (g)	48.7	78.1	84.2	80.2	96.9	88.4	79.4
	Standard deviation weight (g)	9.2	17.0	9.1	17.5	13.3	28.3	23.9
	Average length (mm)	154	175	175	176	189	181	185
	Standard deviation length (mm)	9.3	8.9	1.0	9.7	8.0	14.1	12.6

Table 13.–Summary of age, weight, and length for the Ernest Sound herring stock in 2021–2022.

		Age category						
Gear type, season	Parameter	3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	91	147	3	79	8	15	343
	Percent age composition	27%	43%	1%	23%	2%	4%	100%
	Average weight (g)	48.8	58.0	72.3	69.3	71.6	77.0	66.2
	Standard deviation weight (g)	7.9	10.2	7.1	9.1	8.9	13.1	23.9
	Average length (mm)	153	161	170	172	175	179	185
	Standard deviation length (mm)	6.7	7.0	5.0	6.6	5.7	7.7	12.6

Table 14.–Summary of age, weight, and length for the North Stephen’s Passage herring spawning area in 2021–2022.

Gear type, season	Parameter	Age category 3	4	5	6	7	8+	Total
Survey cast net, spring	Number of fish	158	36	30	367	6	9	606
	Percent age composition	26%	6%	5%	61%	1%	1%	100%
	Average weight (g)	41.1	60.7	55.7	62.3	73.7	79.5	62.2
	Standard deviation weight (g)	11.4	11.4	11.8	14.8	22.2	15.3	14.5
	Average length (mm)	144	163	162	166	172	184	165
	Standard deviation length (mm)	11.4	10.3	7.2	9.1	13.6	8.8	10.1

Table 15.–Summary of Southeast Alaska herring target levels for the 2021–2022 season.

Area	Minimum spawning biomass threshold (tons)	Forecast (tons)	Target exploitation Rate (%)[a]	Guideline harvest level (tons)
Craig	5,000	63,250	20.0	12,650
Ernest Sound	2,500	–	0.0	–
Hobart Bay–Port Houghton	2,000	–	0.0	–
Hoonah Sound	2,000	–	0.0	–
Seymour Canal	3,000	–	0.0	–
Sitka Sound	25,000	225,820	20.0	45,164
Tenakee Inlet	3,000	–	0.0	–
West Behm Canal	6,000	–	0.0	–
Lynn Canal	5,000	–	0.0	–
Kah Shakes–Cat Island	6,000	–	0.0	–

Note: En dashes indicate no data or data not applicable.

[a] Represents the total target exploitation for all fisheries on a particular stock; actual allocations by fishery are determined according to Alaska Administrative Code Title 5 under 5 AAC 27.160, 27.185, and 27.190.

Table 16.–Summary of commercial herring harvest during the 2021–2022 season.

Fishery	Gear	Area	District	Opening[a]	Closing[b]	Harvest (tons)[c]
Winter food and bait	Purse seine	Craig	3/4	1 Oct 2021	28 Feb 2022	398
Winter food and bait	Purse seine	Tenakee Inlet	12	Not open	Not open	–
Winter food and bait	Purse seine	Ernest Sound	7	Not open	Not open	–
Winter food and bait	Purse seine	Hobart Bay	10	Not open	Not open	–
Subtotal						504
Sac roe	Purse seine	Sitka Sound	13	26 Mar 2022	10 Apr 2022	25,090
Sac roe	Purse seine	Lynn Canal	11	Not open	Not open	–
Sac roe	Gillnet	Seymour Canal	11	Not open	Not open	–
Sac roe	Gillnet	Hobart Bay	10	Not open	Not open	–
Sac roe	Gillnet	Kah Shakes	1	Not open	Not open	–
Sac roe	Gillnet	West Behm Canal	1	Not open	Not open	–
Subtotal						25,090
Spawn on kelp	Pound	Hoonah Sound	13	Not open	Not open	–
Spawn on kelp	Pound	Tenakee Inlet	12	Not open	Not open	–
Spawn on kelp	Pound	Ernest Sound	7	Not open	Not open	–
Spawn on kelp	Pound	Craig	3	17 Mar 2022	18 Apr 2022	193
Subtotal						193
Test fishery-bait	Purse seine	Sitka	13	No fishery	No fishery	–

Note: En dashes indicate no data or data not applicable.

[a] For spawn-on-kelp fisheries, represents when seining was opened.

[b] For spawn-on-kelp fisheries, represents end of removing spawn on kelp from pounds; for purse seine fisheries represents date of last opening.

[c] Values expressed in tons of whole herring, except for spawn-on-kelp fisheries, values are tons of eggs-on-kelp product.

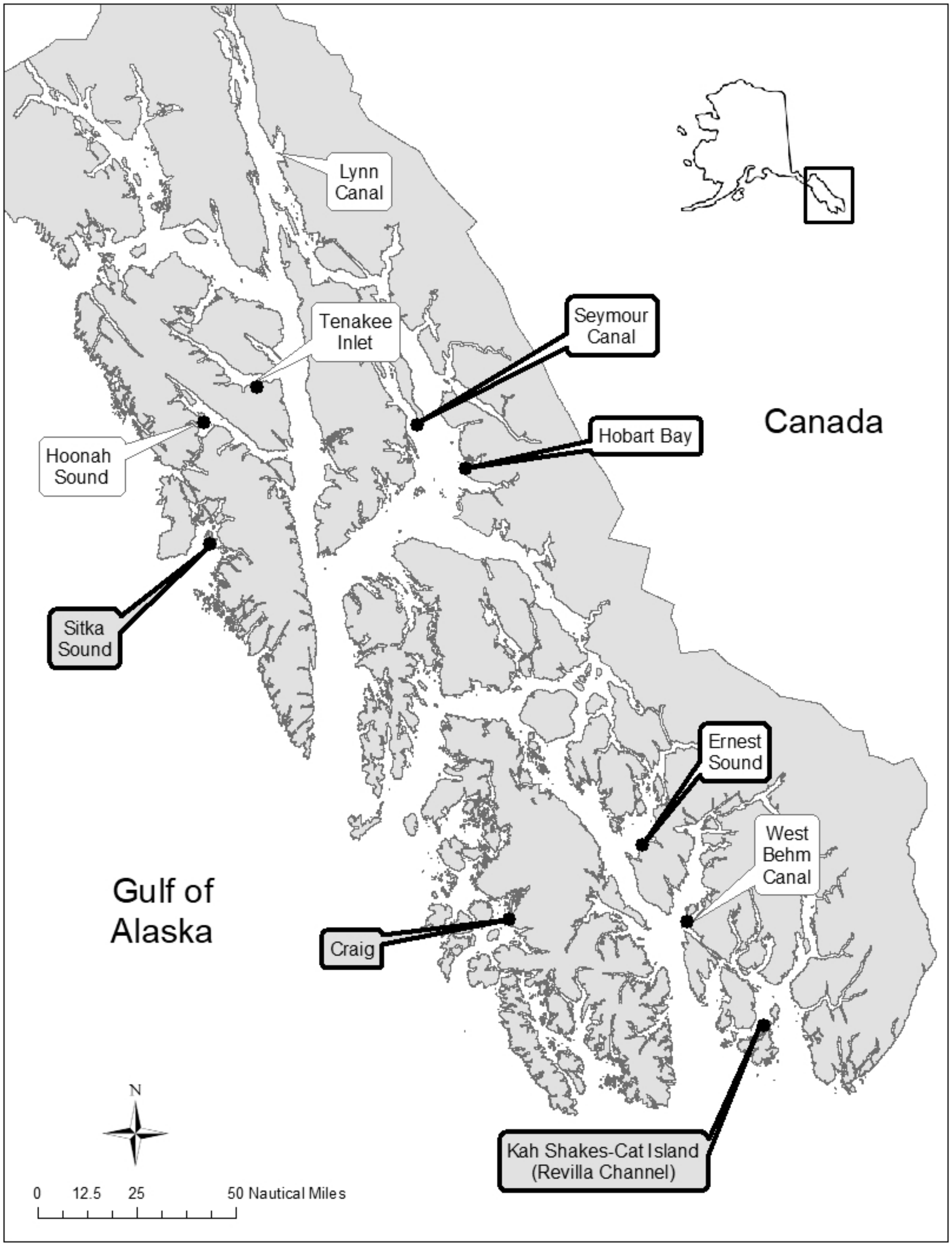

Figure 1.–Locations of monitored traditional herring spawning areas in Southeast Alaska. Labels with shading and bold outline indicate areas where spawn deposition surveys and age-size sampling were conducted during the 2022 spawning season; labels with only bold outline indicate only age-size sampling of herring was completed during the 2022 spawning season; no sampling other than aerial surveys were conducted in areas where labels have no shading or bolding.

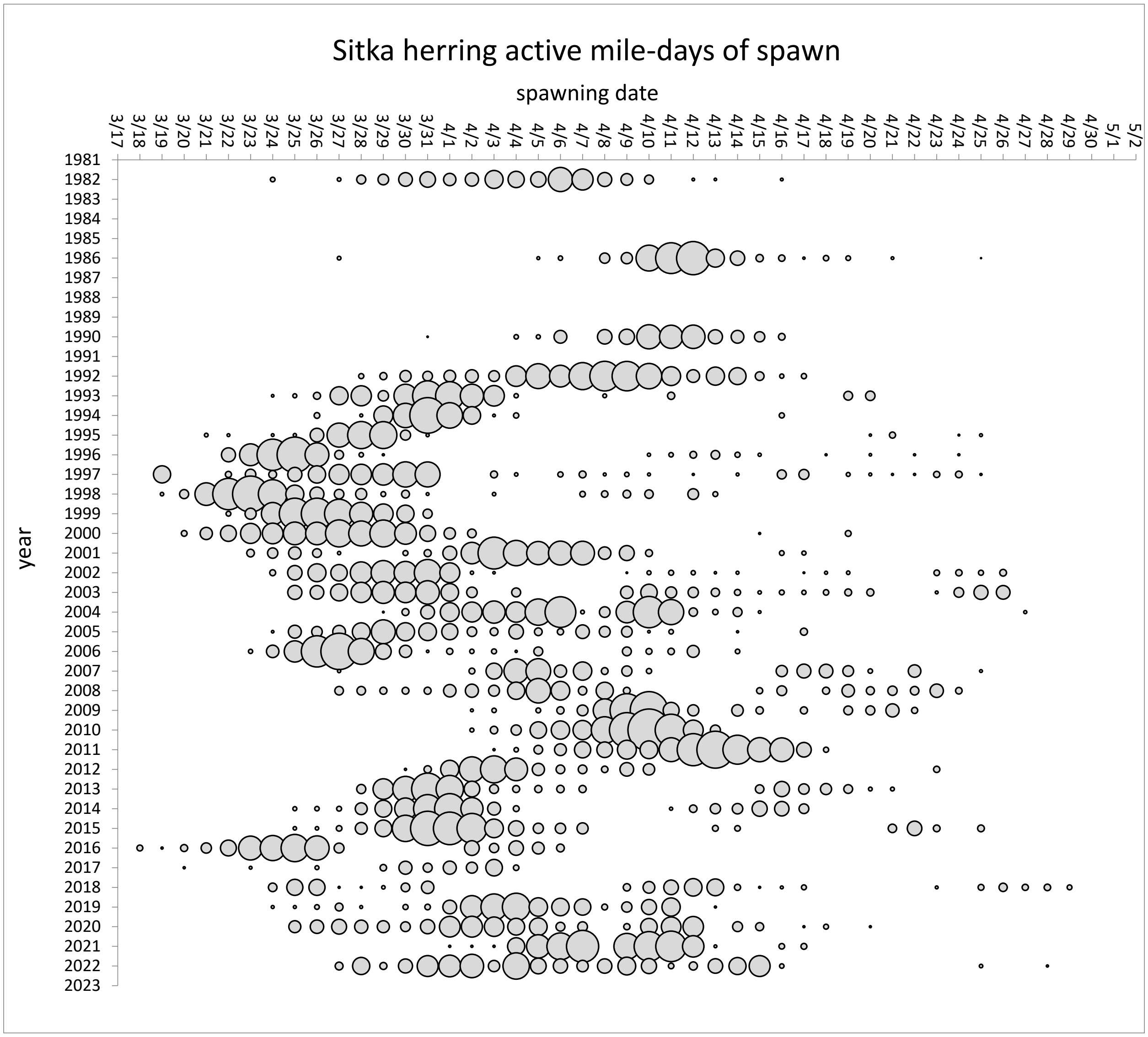

Figure 2.–Historical dates of active spawn observed for the Sitka Sound herring stock. The size of circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of 48 nautical miles of spawn and the smallest circles represent "spot spawns", which here have been given an arbitrary value of 0.1 nautical mile. For entire years with blanks, data could not be located.

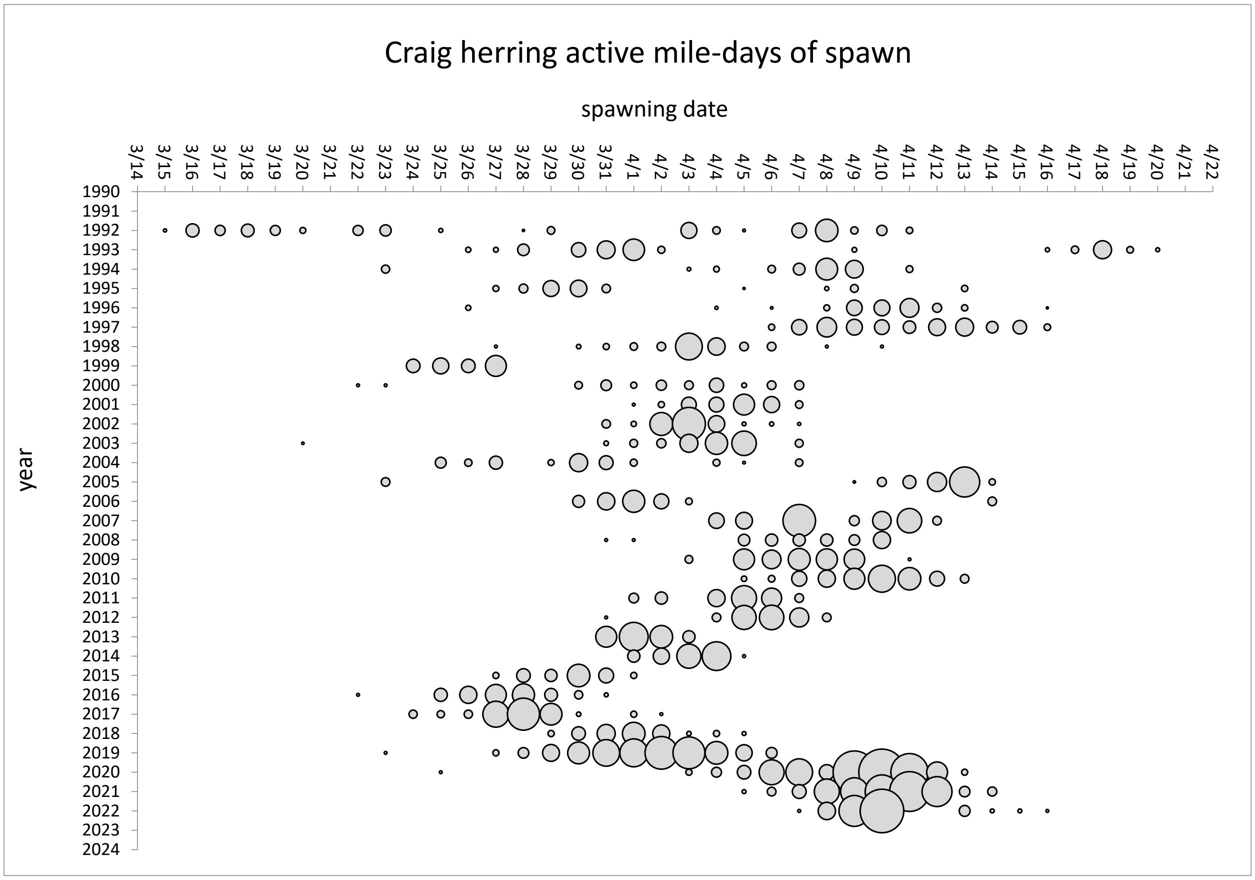

Figure 3.–Historical dates of active spawn observed for the Craig herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 30 nautical miles of spawn and the smallest circles represent "spot spawns", which here have been given an arbitrary value of 0.1 nautical mile. Black circles represent days of active spawn, but for which no estimates of daily mileage are available.

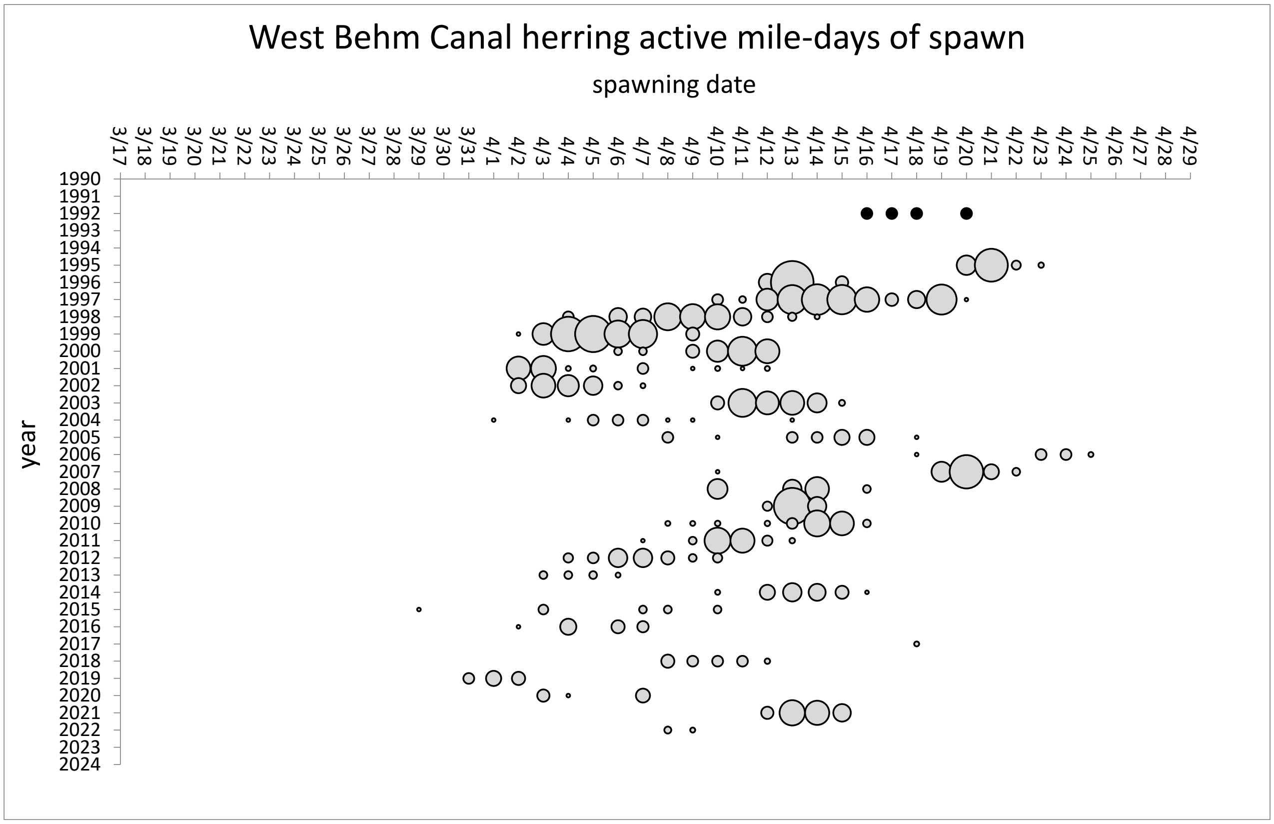

Figure 4.–Historical dates of active spawn observed for the West Behm Canal herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of 12 nautical miles of spawn and the smallest circles represent "spot spawns", which here have been given an arbitrary value of 0.1 nautical mile. Black circles represent days of active spawn, but for which no estimates of daily mileage are available. For years with blanks, data could not be located.

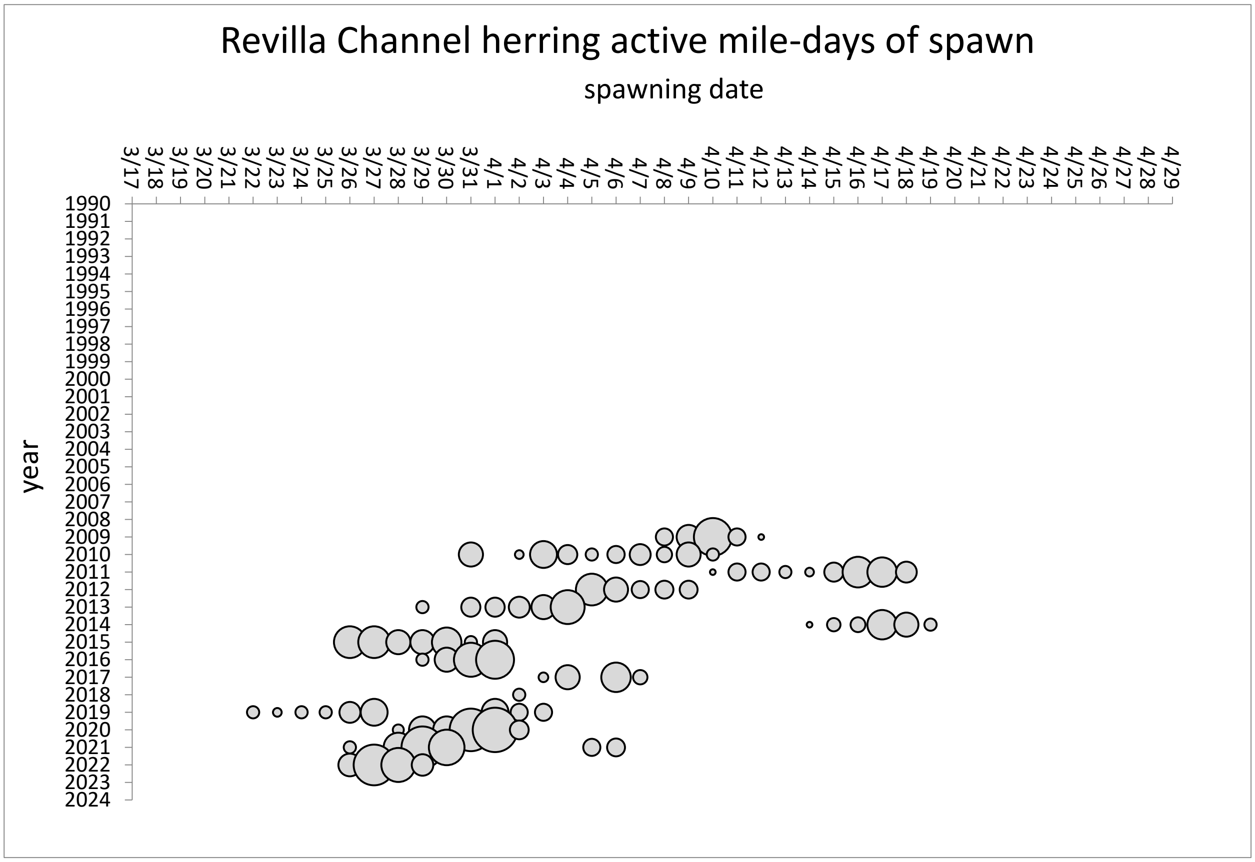

Figure 5.–Historical dates of active spawn observed for the Revilla Channel herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 7 nautical miles of spawn and the smallest circles represent “spot spawns”, which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located or is not yet summarized.

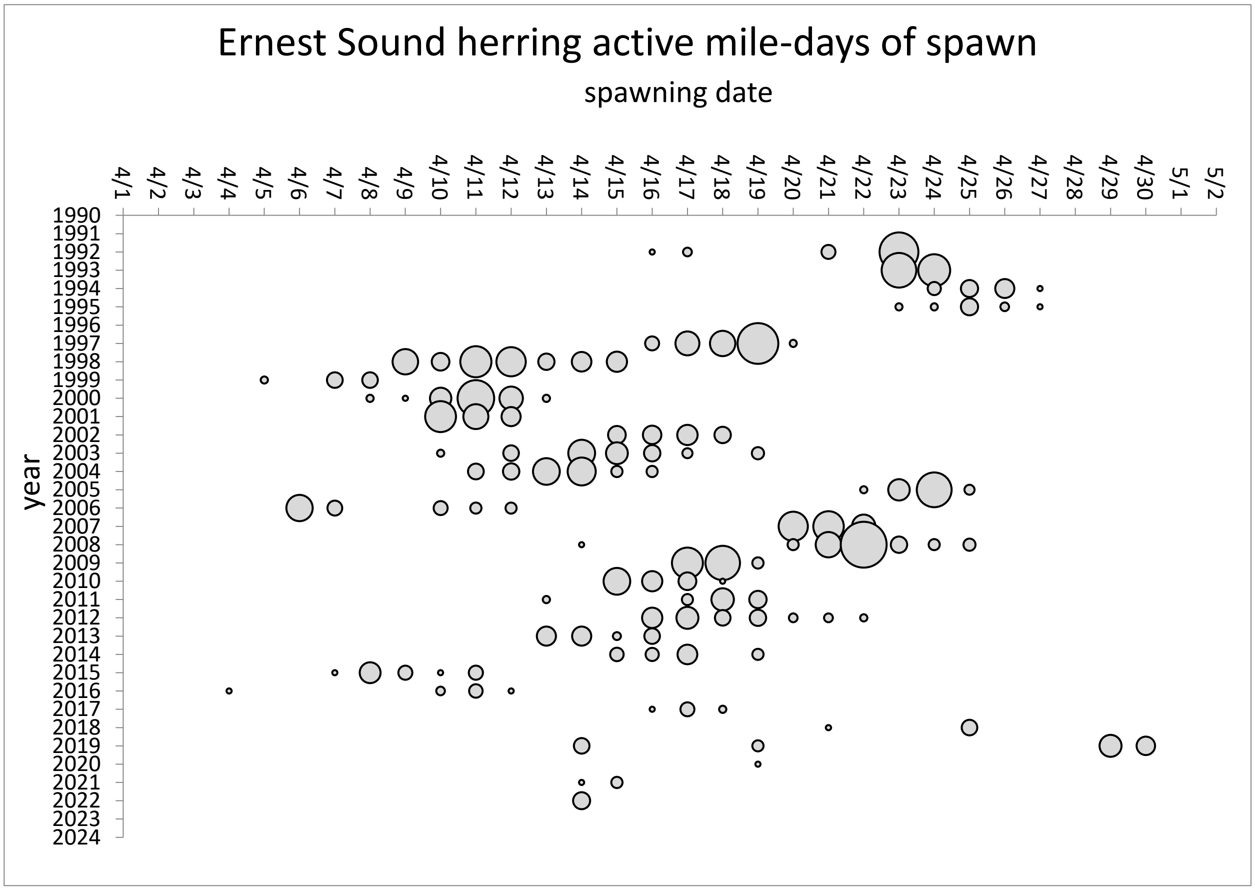

Figure 6.–Historical dates of active spawn observed for the Ernest Sound herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 9 nautical miles of spawn and the smallest circles represent “spot spawns”, which here have been given an arbitrary value of 0.1 nautical mile.

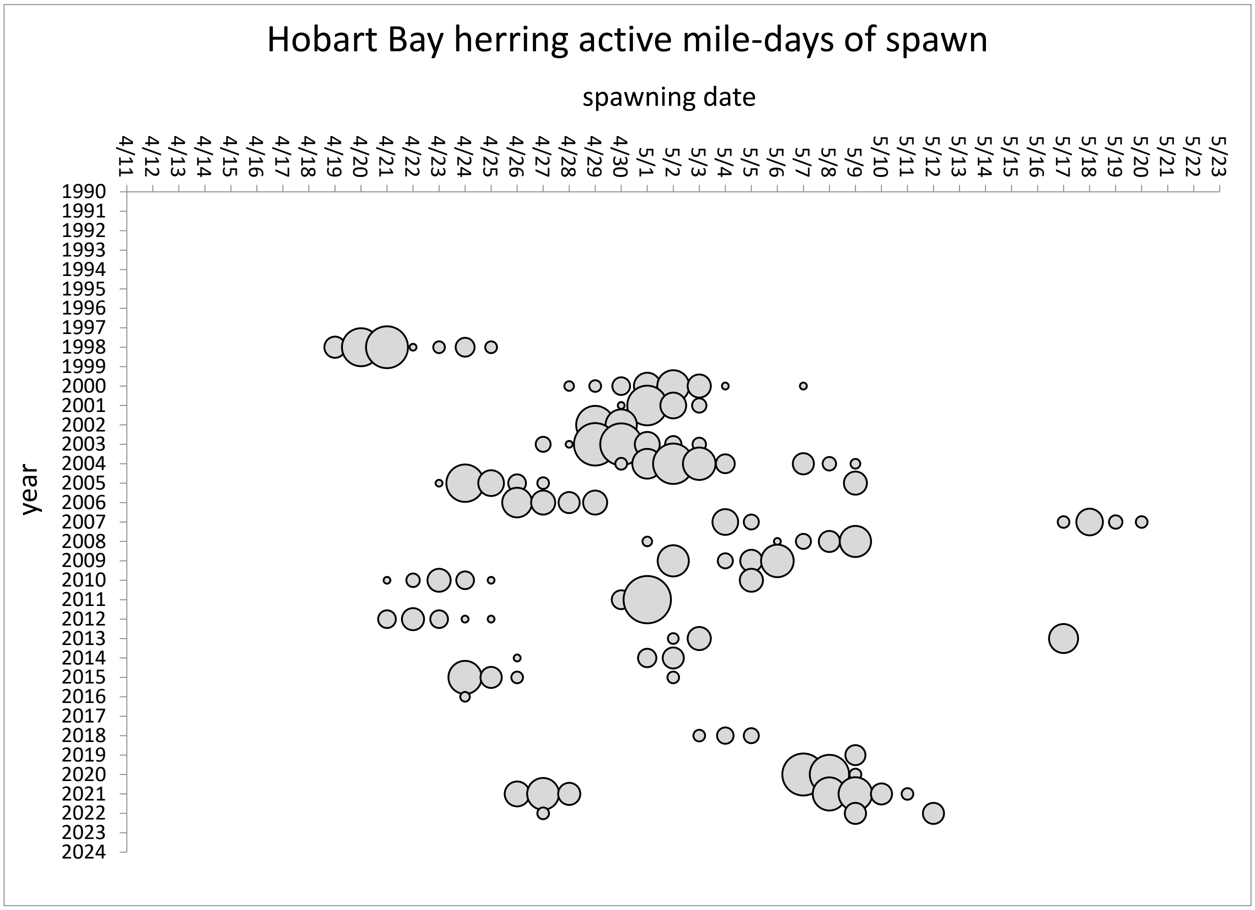

Figure 7.–Historical dates of active spawn observed for the Hobart Bay herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 6 nautical miles of spawn and the smallest circles represent "spot spawns", which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located.

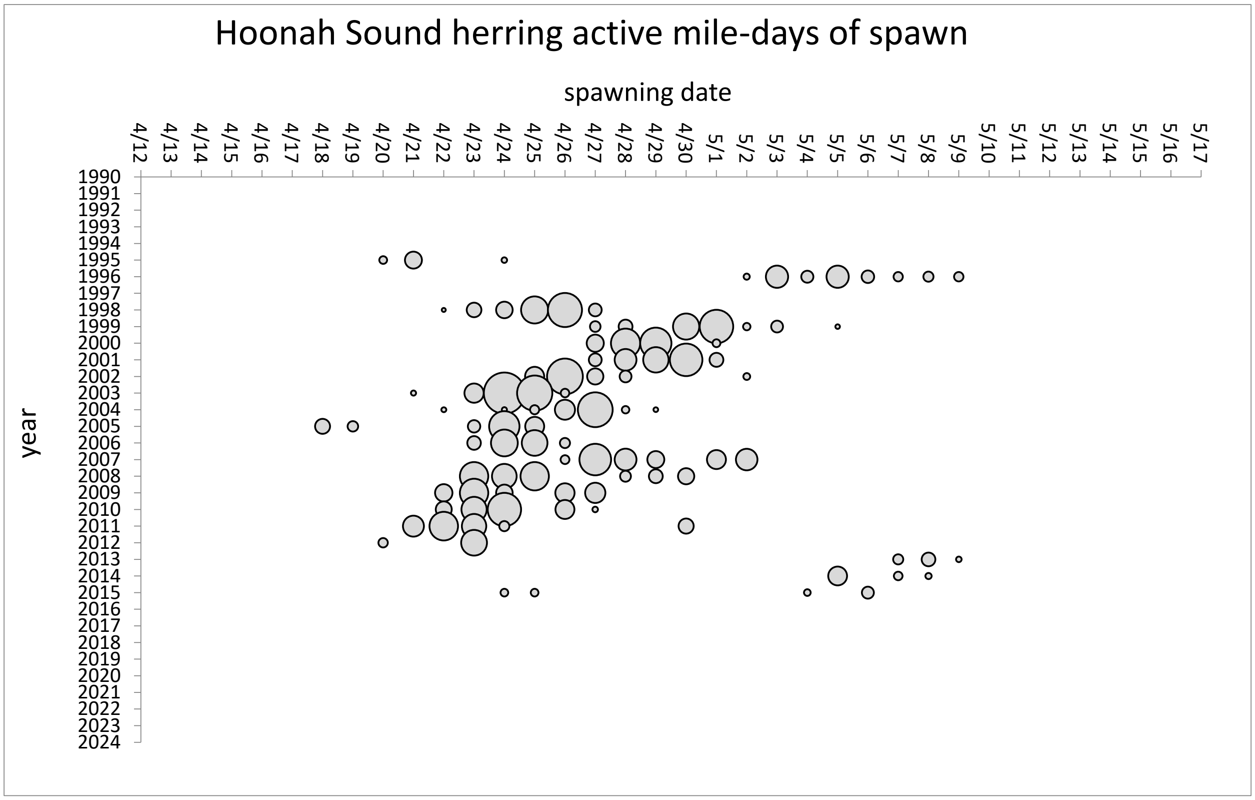

Figure 8.–Historical dates of active spawn observed for the Hoonah Sound herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 12 nautical miles of spawn and the smallest circles represent "spot spawns", which here have been given an arbitrary value of 0.1 nautical mile. For years prior to 1995, data could not be located. For entire blank years since 2015 spawn has not been observed, although aerial survey flights have been much less frequent than were done in prior years.

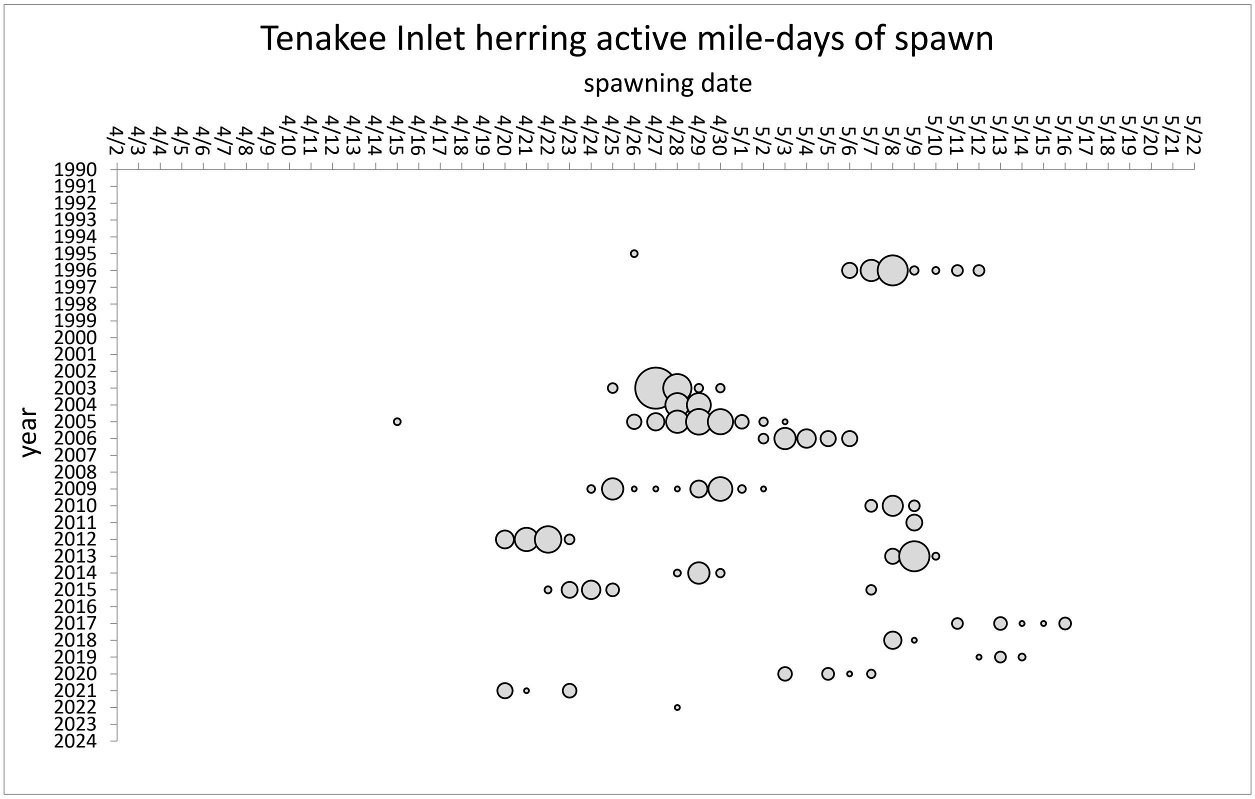

Figure 9.–Historical dates of active spawn observed for the Tenakee Inlet herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 8 nautical miles of spawn and the smallest circles represent "spot spawns", which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located.

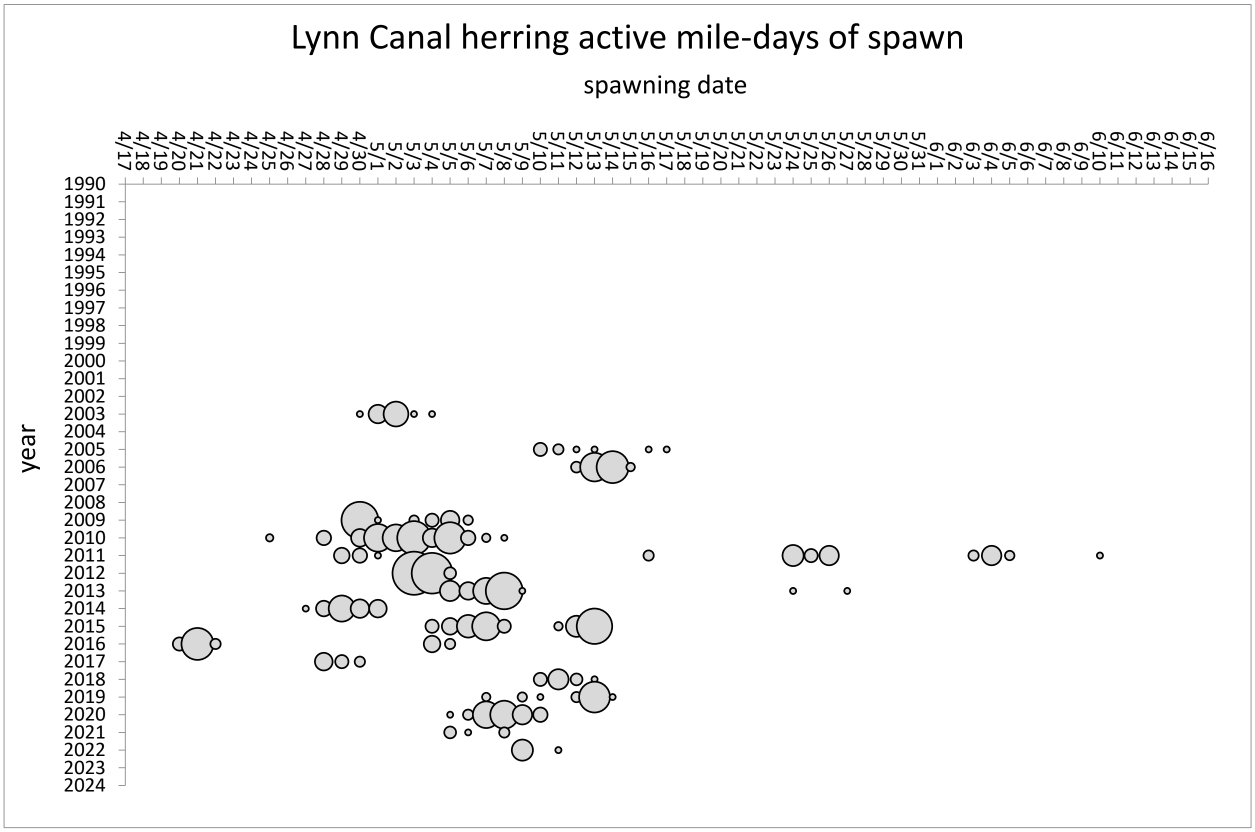

Figure 10.–Historical dates of active spawn observed for the Lynn Canal herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 5 nautical miles of spawn and the smallest circles represent “spot spawns”, which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located or is not yet summarized.

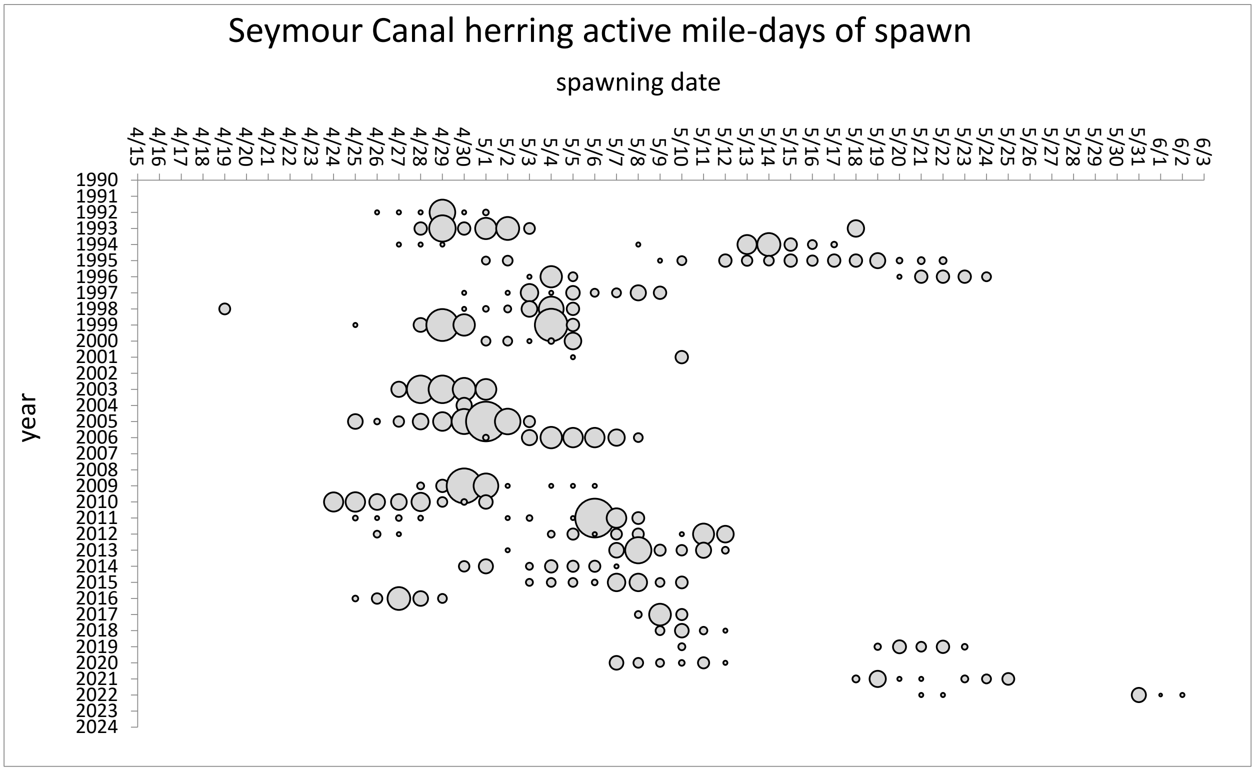

Figure 11.–Historical dates of active spawn observed for the Seymour Canal herring stock. The size of gray circles represents the total mileage of active spawn observed on each day, relative to all other days of spawn. For reference, the largest circle represents a day of about 10 nautical miles of spawn and the smallest circles represent "spot spawns", which here have been given an arbitrary value of 0.1 nautical mile. For years with blanks, data could not be located.

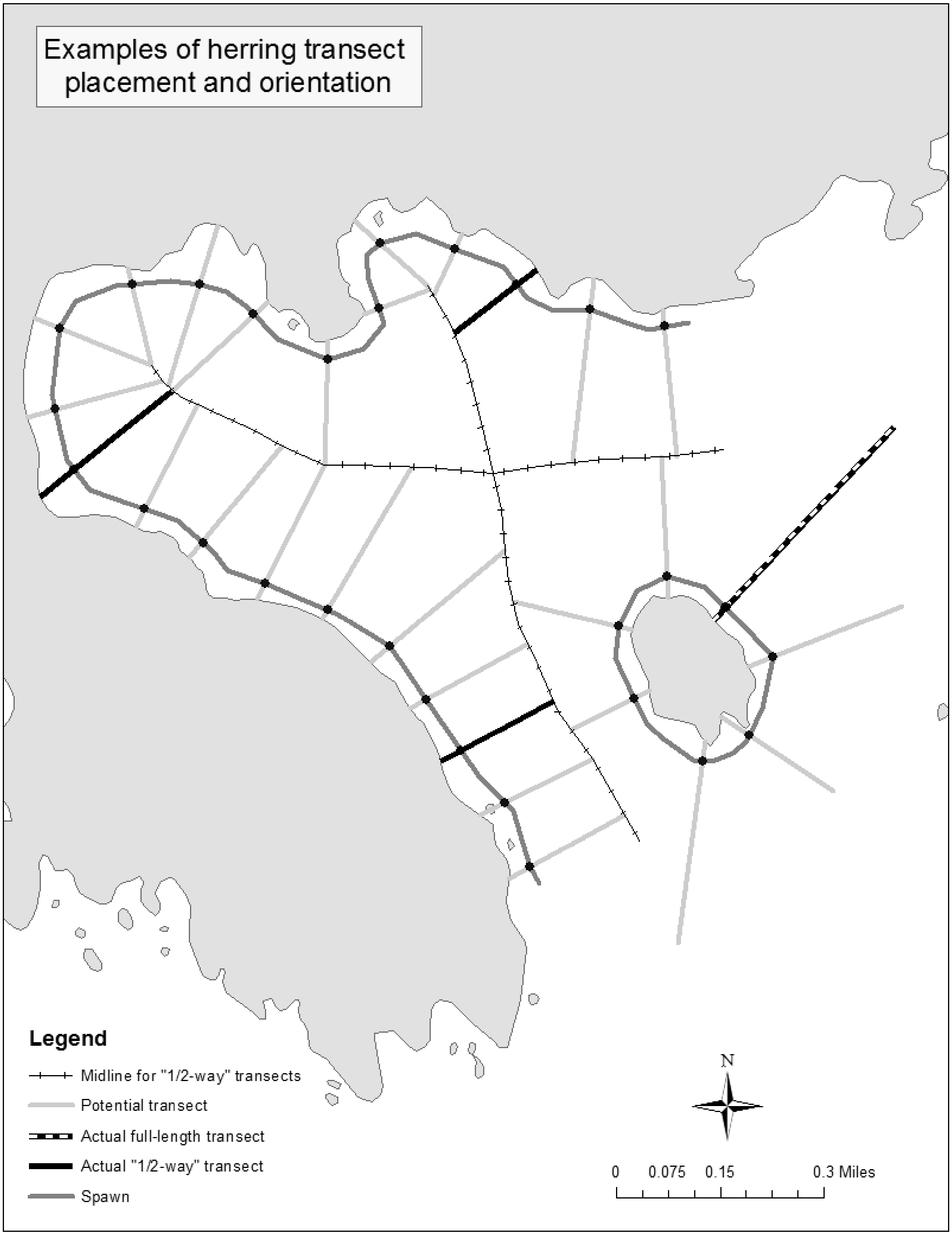

Figure 12.–Example of hypothetical herring transect placement and orientation, representing points at which transects should be halted to prevent oversampling.

Stock	8-Mar	9-Mar	10-Mar	11-Mar	12-Mar	13-Mar	14-Mar	15-Mar	16-Mar	17-Mar	18-Mar	19-Mar	20-Mar	21-Mar	22-Mar	23-Mar	24-Mar	25-Mar	26-Mar	27-Mar	28-Mar	29-Mar	30-Mar	31-Mar	1-Apr	2-Apr	3-Apr	4-Apr	5-Apr	6-Apr	7-Apr	8-Apr	9-Apr	10-Apr	11-Apr	12-Apr	13-Apr	14-Apr	15-Apr
Sitka Sound	0.0	ns	ns	ns	0.0	ns	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	8.0	1.3	5.3	11.9	12.9	15.1	3.4	19.1	6.7	5.5	3.5	5.6	8.6	6.2	0.8	1.8	5.7	7.9	11.9
Revilla Channel														ns	0.0	ns	ns	ns	1.8	5.8	4.0	1.3	0.0	0.0	ns	ns	ns	0.0	ns										
Craig											0.0	ns	ns	ns	ns	ns	ns	ns	0.0	ns	ns	ns	ns	0.0	ns	ns	ns	0.0	ns	ns	0.1	4.1	13.2	26.4	ns	ns	1.6	0.2	0.2
West Behm Canal																														ns	0.0	0.4	0.2	0.0	ns	ns	0.0	0.0	0.0
Ernest Sound																																					ns	1.2	0.0
Seymour Canal																																						ns	0.0
N. Stephens Pass.																																						ns	0.0
Tenakee Inlet																																						ns	0.0
Lynn Canal																																						ns	0.0

continued	16-Apr	17-Apr	18-Apr	19-Apr	20-Apr	21-Apr	22-Apr	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr	30-Apr	1-May	2-May	3-May	4-May	5-May	6-May	7-May	8-May	9-May	10-May	11-May	12-May	13-May	14-May	15-May	16-May	17-May	18-May	19-May	20-May	21-May	22-May	23-May	24-May
Sitka Sound	0.5	0.0	0.0	ns	ns	0.0	0.0	ns	ns	0.3	ns	ns	0.1																										
Craig	0.1	ns																																					
West Behm Canal	0.0	active spawn not observed but 1.0 nmi reported sometime Apr 17-28.																																					
Ernest Sound	ns	ns	0.0	ns	ns	0.0	0.0	ns																															
Hoonah Sound		ns	0.0	ns	ns	0.0	ns	ns	ns	0.0	ns	ns	0.0	ns																									
Seymour Canal	ns	ns	ns	ns	0.0	ns	ns	ns	ns	0.0	ns	ns	0.0	ns	ns	ns	0.0	ns	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	ns	0.0	ns	0.0	ns	0.0	0.1	0.1	0.0	ns
N. Stephens Pass.	ns	ns	ns	ns	0.0	ns	ns	ns	ns	0.0	ns	ns	0.0	ns	ns	ns	0.0	ns	ns	ns	0.0	ns	ns	0.0	ns	ns	0.0	ns	ns	ns	0.0	ns	0.0	ns	0.1	1.7	0.4	2.4	0.0
Tenakee Inlet	ns	ns	ns	ns	0.0	ns	ns	ns	ns	0.0	ns	ns	0.1	ns	ns	ns	0.0	ns	ns	ns	0.0	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.0	ns					
Lynn Canal	ns	ns	ns	ns	0.0	ns	ns	ns	ns	0.0	ns	ns	0.0	ns	ns	ns	0.0	ns	0.0	ns	0.0	ns	ns	1.3	ns	0.1	0.0	ns	ns	ns	ns	ns	0.0	ns					
Hobart/Houghton						ns	0.0	ns	ns	0.0	ns	0.3	0.0	ns	0.0	ns	ns	ns	0.0	ns	ns	0.0	ns	1.0	0.0	ns	1.0	0.0	ns										
Haines													0.1																										
Yakutat Bay			1.8 nmi observed over this time period																																				

continued	25-May	26-May	27-May	28-May	29-May	30-May	31-May	1-Jun	2-Jun	3-Jun	4-Jun	5-Jun	6-Jun	7-Jun	8-Jun	9-Jun	10-Jun	11-Jun	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun	19-Jun	20-Jun	21-Jun	22-Jun	23-Jun	24-Jun	25-Jun	26-Jun	27-Jun	28-Jun	29-Jun	30-Jun	1-Jul	2-Jul
Seymour Canal	0.0	ns	0.0	ns	ns	ns	1.3	0.04	0.1	ns																													
N. Stephens Pass.	0.0	ns	0.0	ns	ns	ns	0.0	0.0	0.0	ns																													

Figure 13.–Spawn timing of herring stocks in Southeast Alaska during spring 2022. Values indicate daily measurements of nautical miles of active spawn recorded during aerial surveys. Shaded area depicts dates when cast-net samples were taken. Boxed areas indicate duration of spawning (first to last dates of observed spawn). Dates with no survey are depicted by “ns”. Blank dates indicate dates that are outside of historical spawning timing and so surveys had not commenced or were concluded.

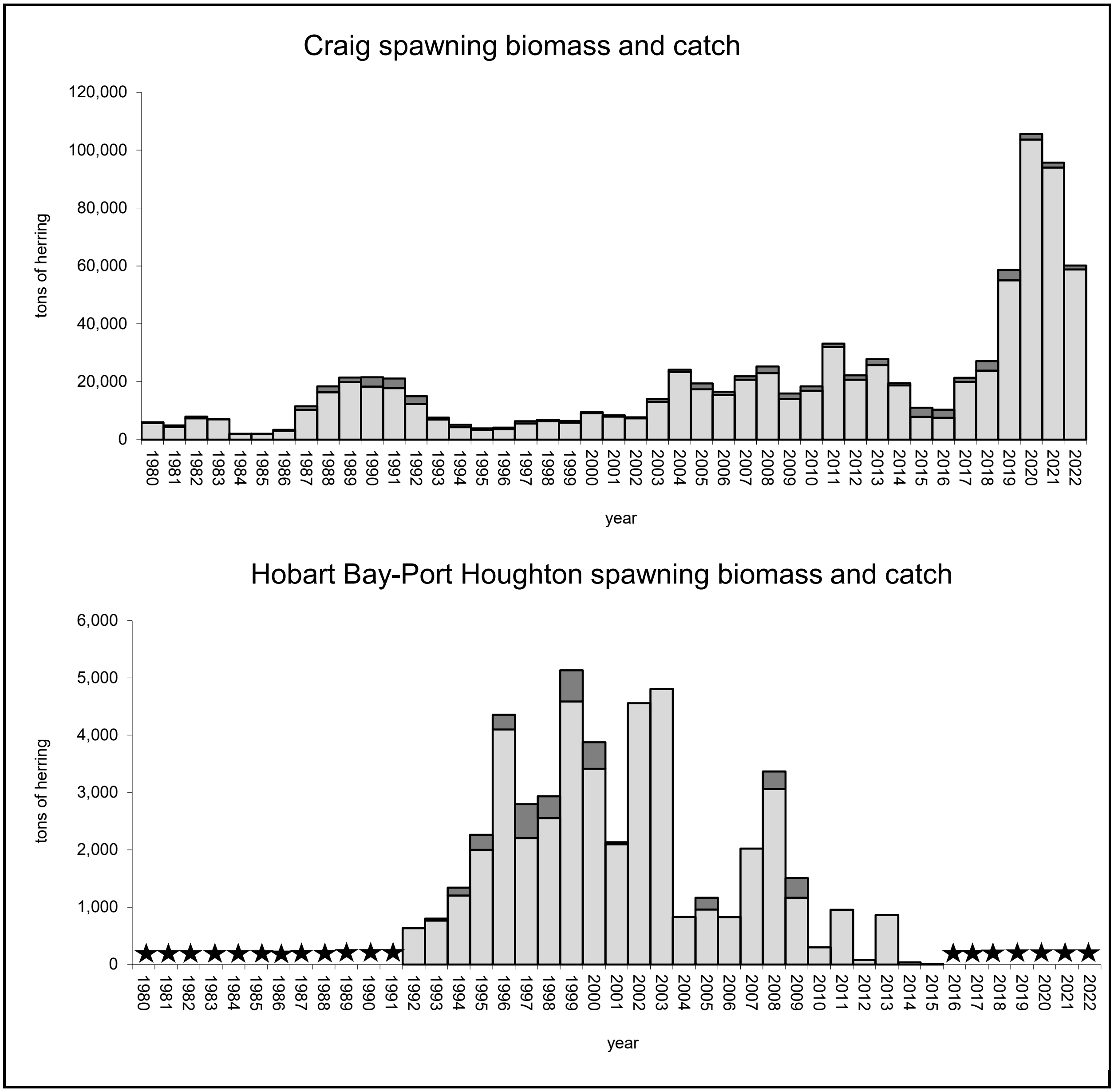

Figure 14.–Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stocks in the Craig and Hobart Bay–Port Houghton areas, during 1980–2022. Stars represent years when spawn deposition surveys were not conducted.

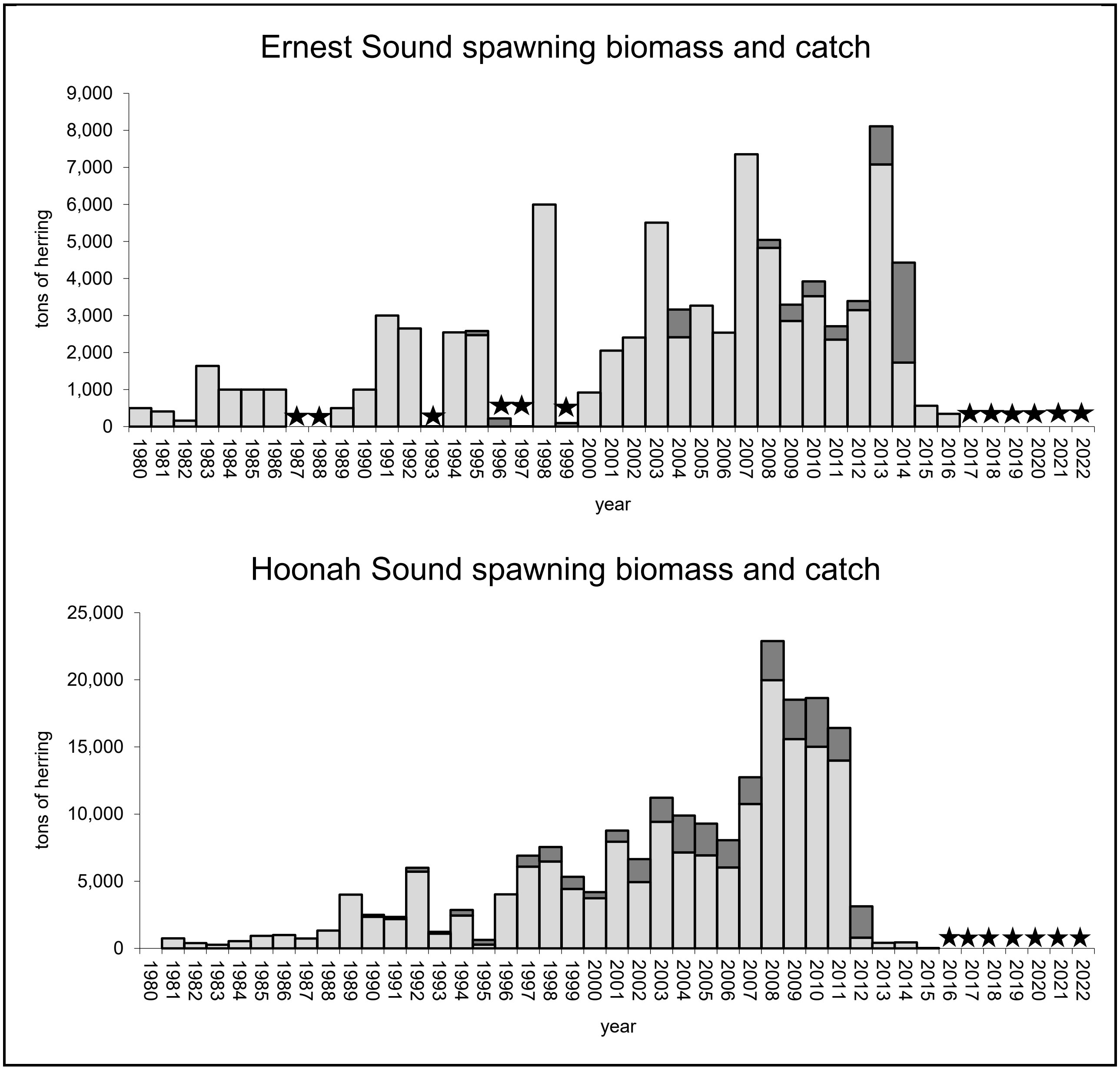

Figure 15.–Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys or hydroacoustic surveys, and catch (dark gray bars) for stocks in the Ernest Sound and Hoonah Sound areas, during 1980–2022. Stars represent years when spawn deposition surveys were not conducted.

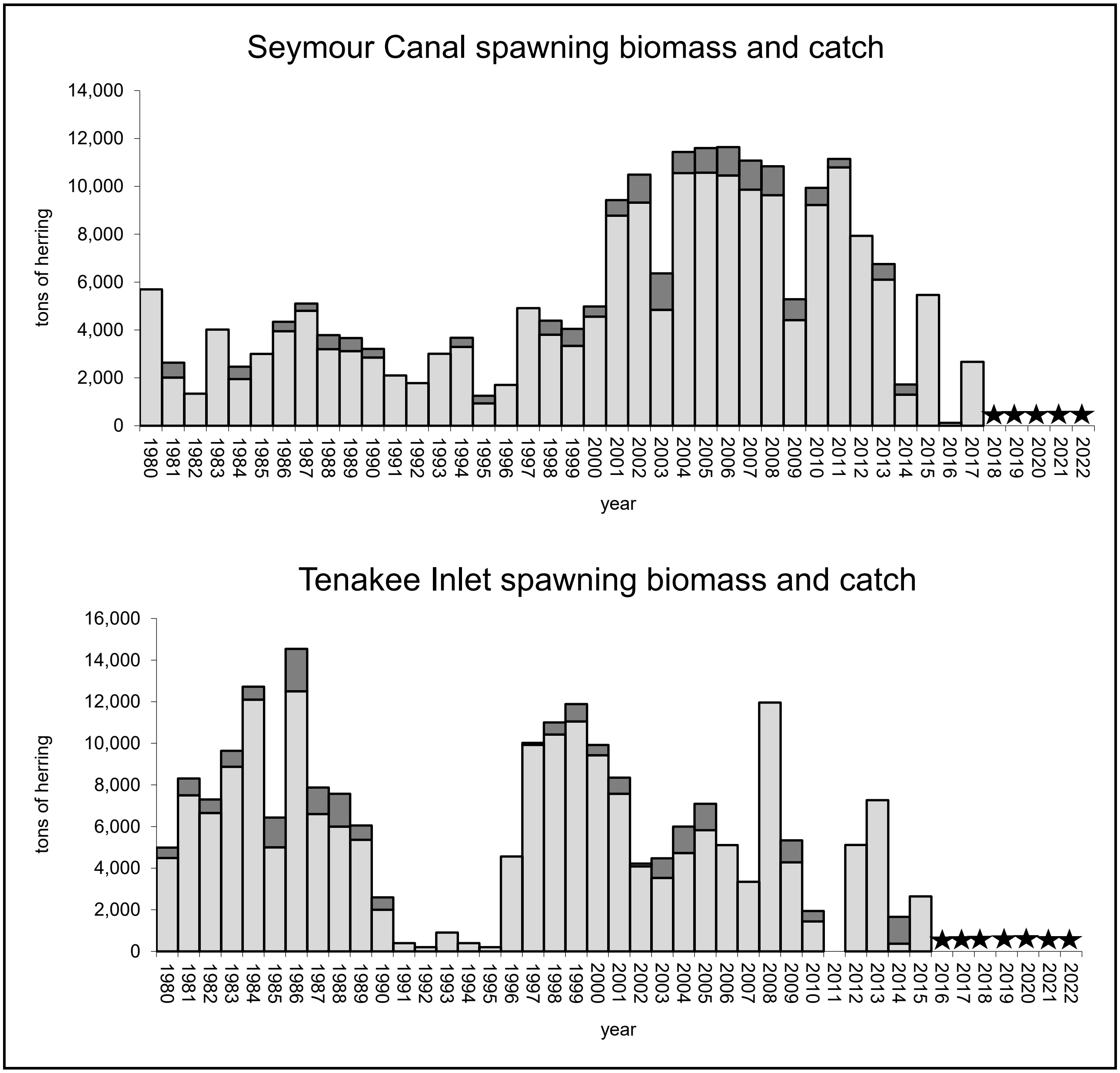

Figure 16.–Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys or hydroacoustic surveys, and catch (dark gray bars) for stocks in the Seymour Canal and Tenakee Inlet areas, during 1980–2022. Stars represent years when spawn deposition surveys were not conducted.

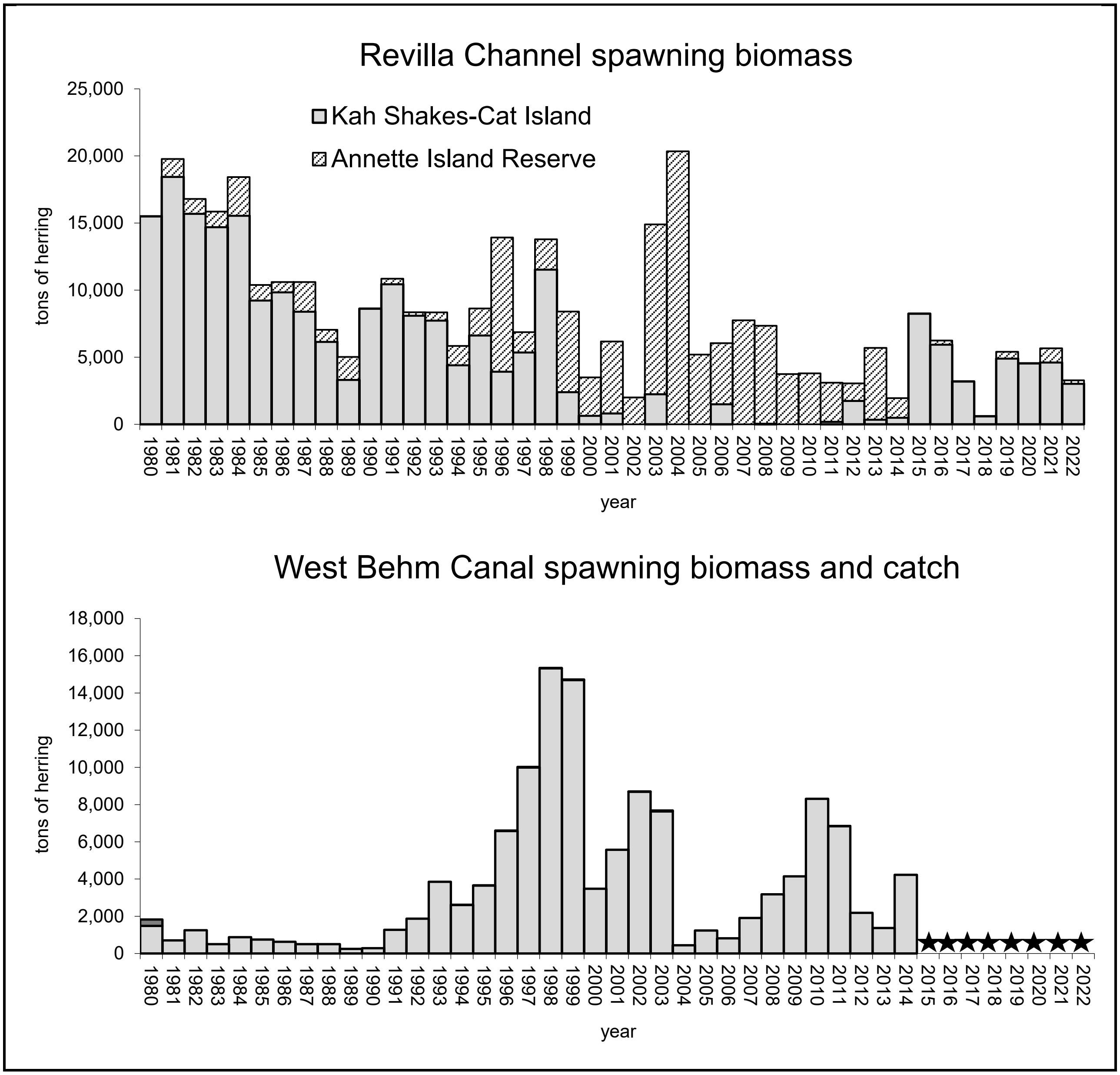

Figure 17.–Observed herring post-fishery spawning biomass, based on spawn deposition surveys or hydroacoustic surveys for stocks in the West Behm Canal and Revilla Channel (Kah Shakes–Cat Island–Annette Island) areas, during 1980–2022. Annette Island spawning biomass estimates between 1981 and 2016 were made as the product of the length of observed linear shoreline spawn mileage and a fixed approximated value of 500 tons of herring per nautical mileage of shoreline, based on the estimated mean value over the period 1991–2000. Stars represent years when spawn deposition surveys were not conducted.

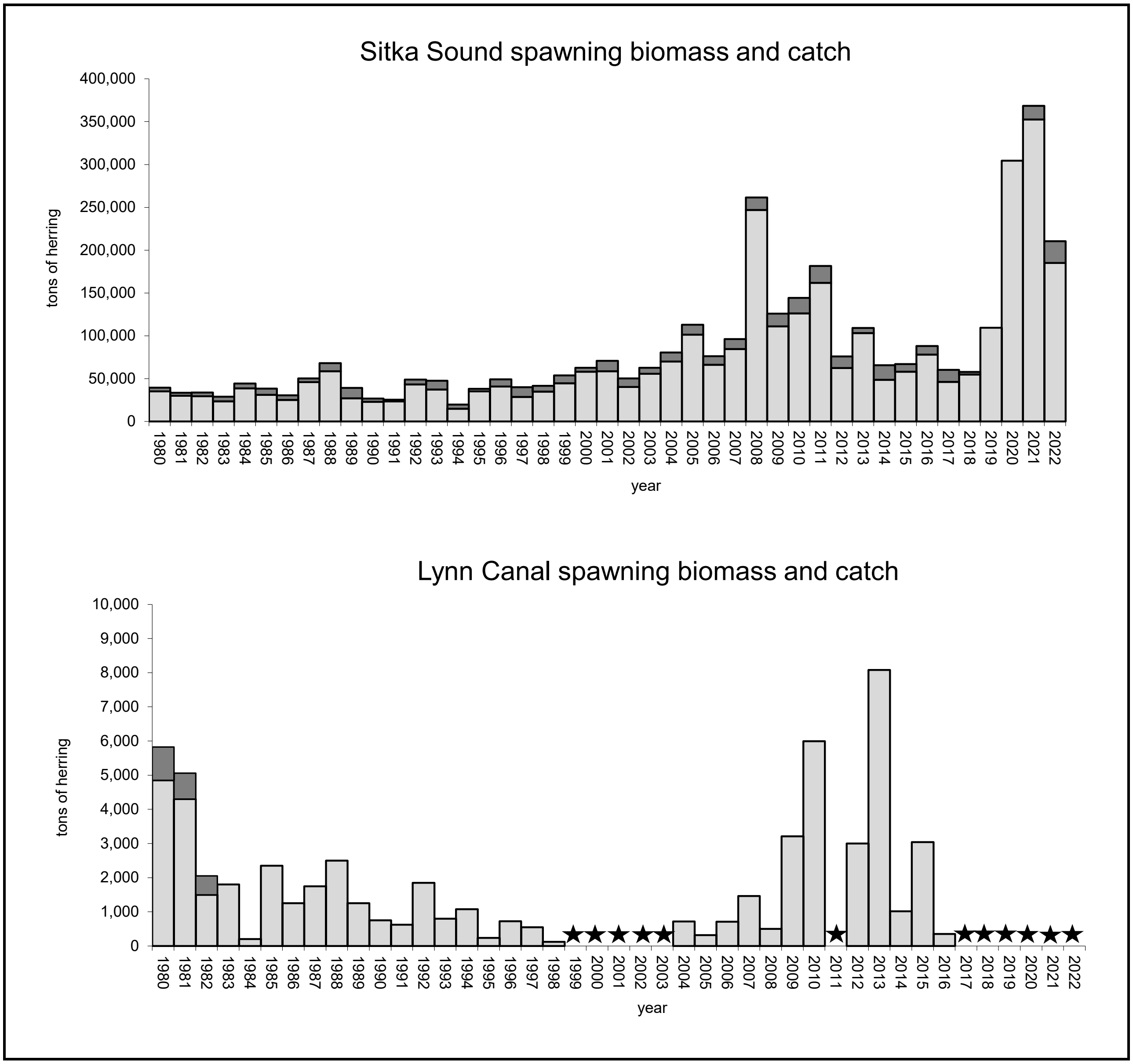

Figure 18.–Observed herring post-fishery spawning biomass (light gray bars), based on spawn deposition surveys, and catch (dark gray bars) for stock in the Sitka Sound and Lynn Canal areas, during 1980–2022. Estimates of spawning biomass for Lynn Canal prior to 2004 were made using a variety of methods (e.g., hydroacoustics or visual estimates of spawn density converted to biomass), and results should be viewed as approximations. Stars represent years when spawn deposition surveys were not conducted.

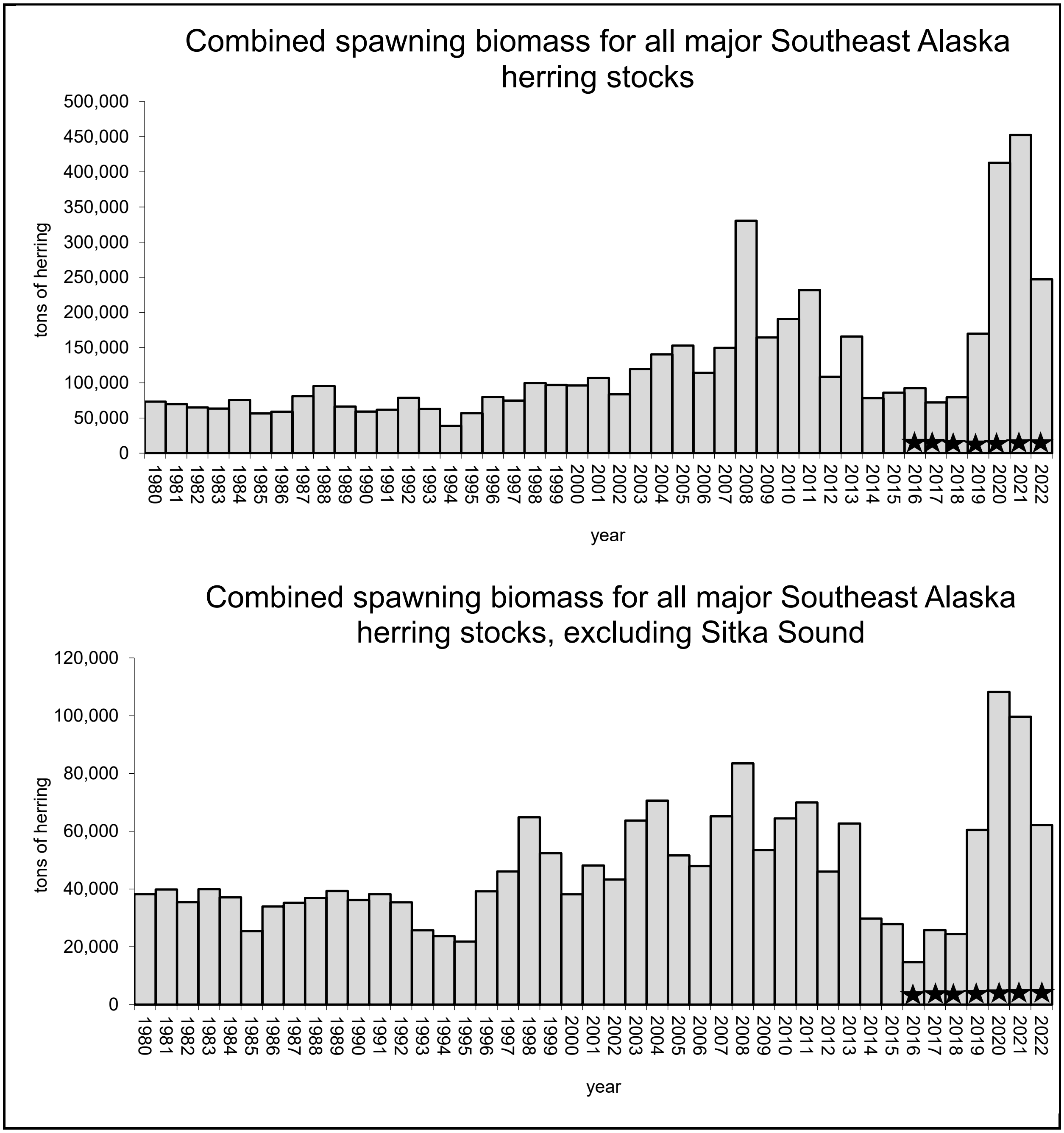

Figure 19.–Combined observed herring post-fishery spawning biomass, based on spawn deposition surveys or hydroacoustic surveys, for major herring stocks in Southeast Alaska, during 1980–2022. Recent years represent an underestimate of regional total biomass, because of the ten major spawning areas that have been historically monitored, the following number of areas were surveyed in recent years: 2016, 6 areas; 2017, 7 areas; 2018, 2 areas; and 2019–2022, 3 areas. Stars represent years when spawn deposition surveys were not conducted in at least one of the ten major spawning areas since 2016.

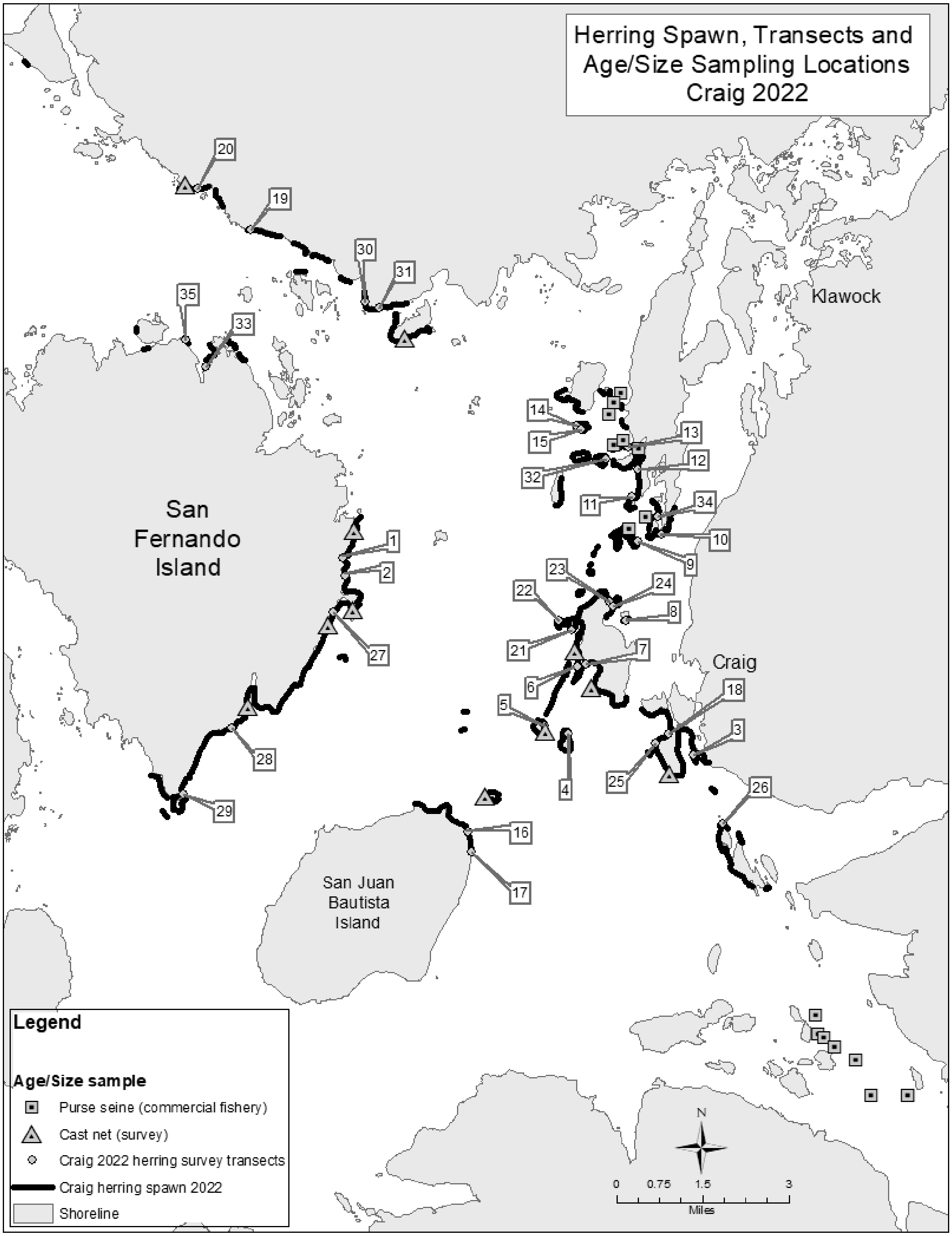

Figure 20.–Locations of herring egg survey transects and samples for estimates of age and size for the Craig herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

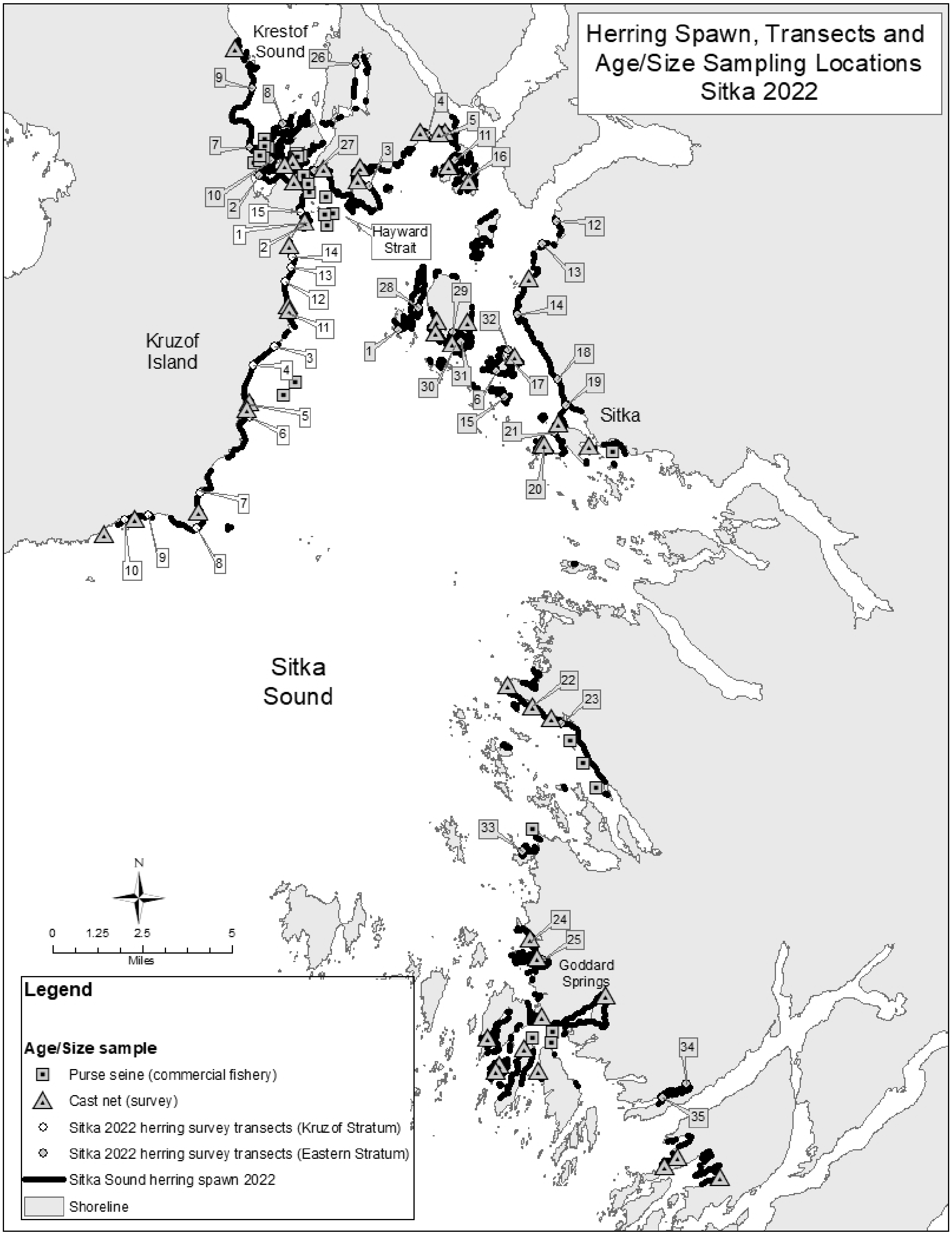

Figure 21.–Locations of herring egg survey transects and samples collected for estimates of age and size for the Sitka Sound herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

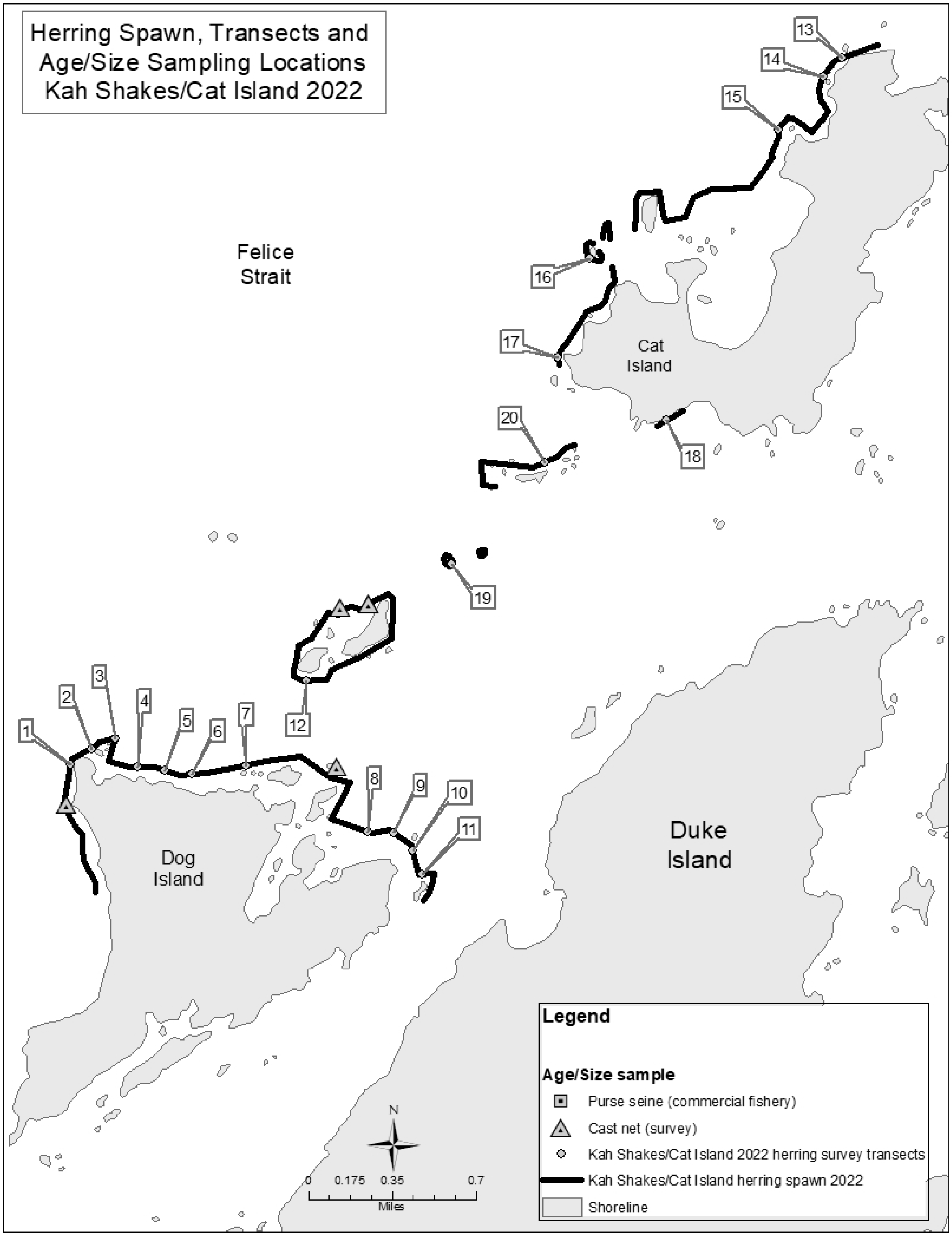

Figure 22.–Locations of herring egg survey transects and samples collected for estimates of age and size for the Kah Shakes–Cat Island (Revilla Channel) herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

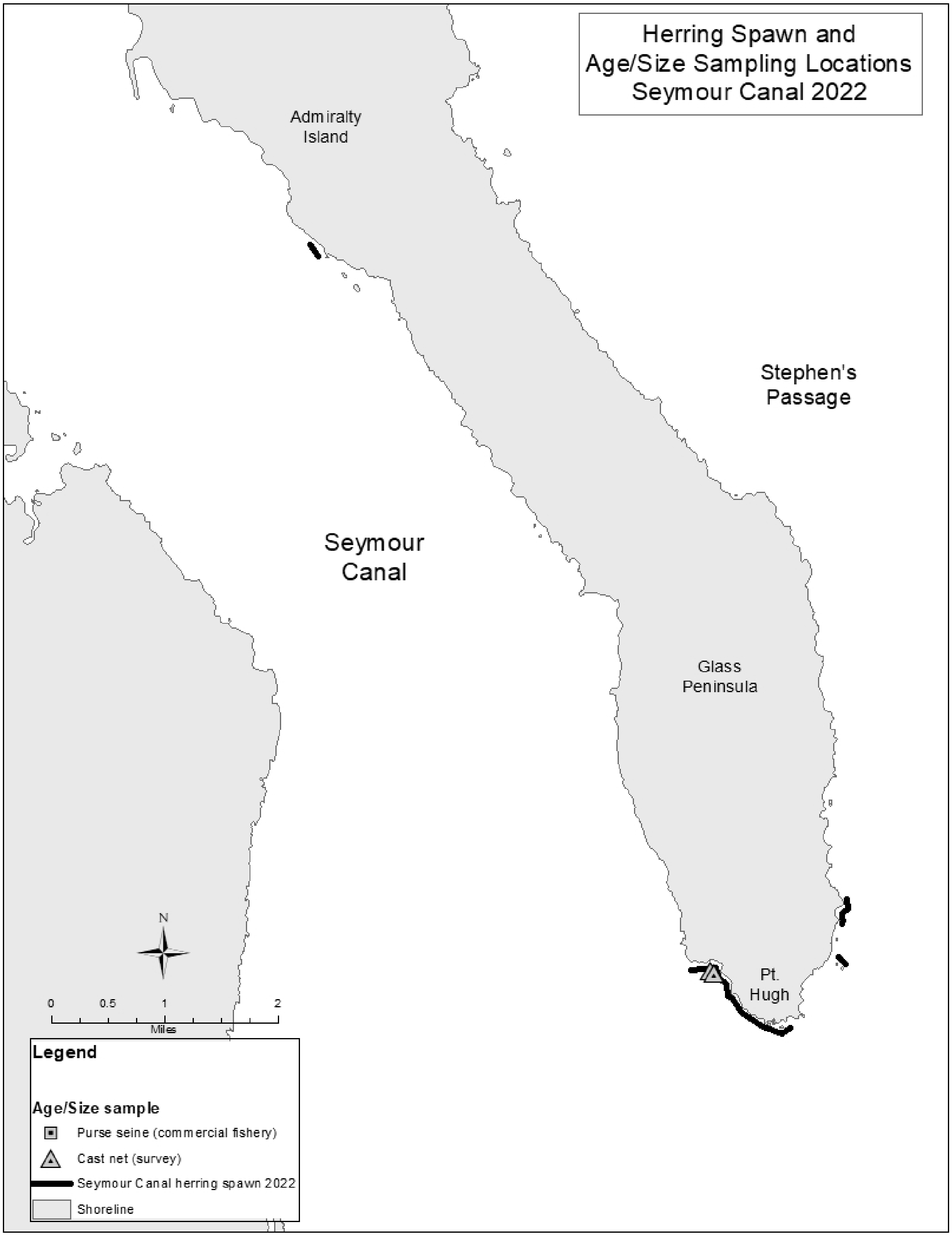

Figure 23.–Locations of herring samples collected for estimates of age and size for the Seymour Canal herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

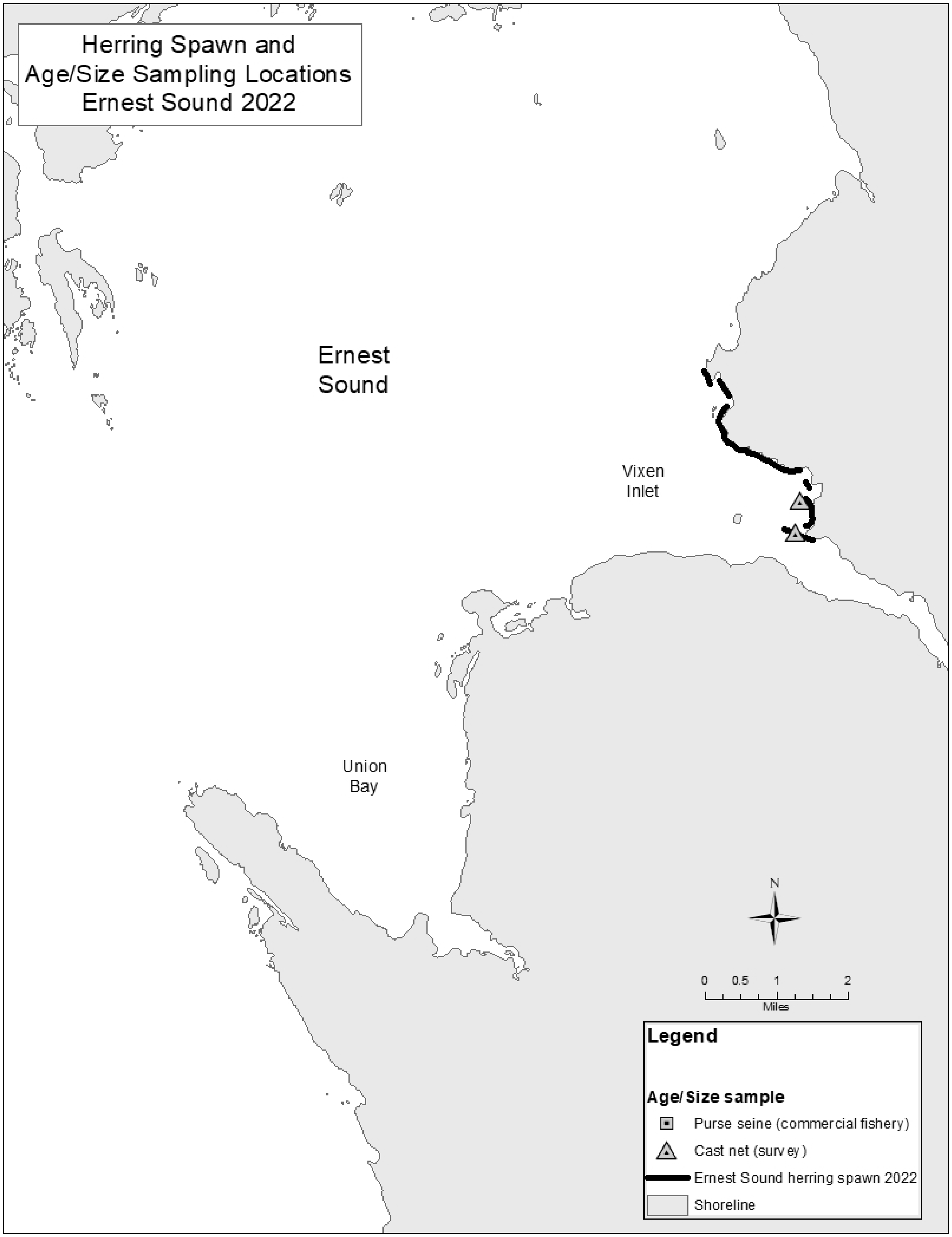

Figure 24.–Locations of herring spawn observed for the Ernest Sound herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

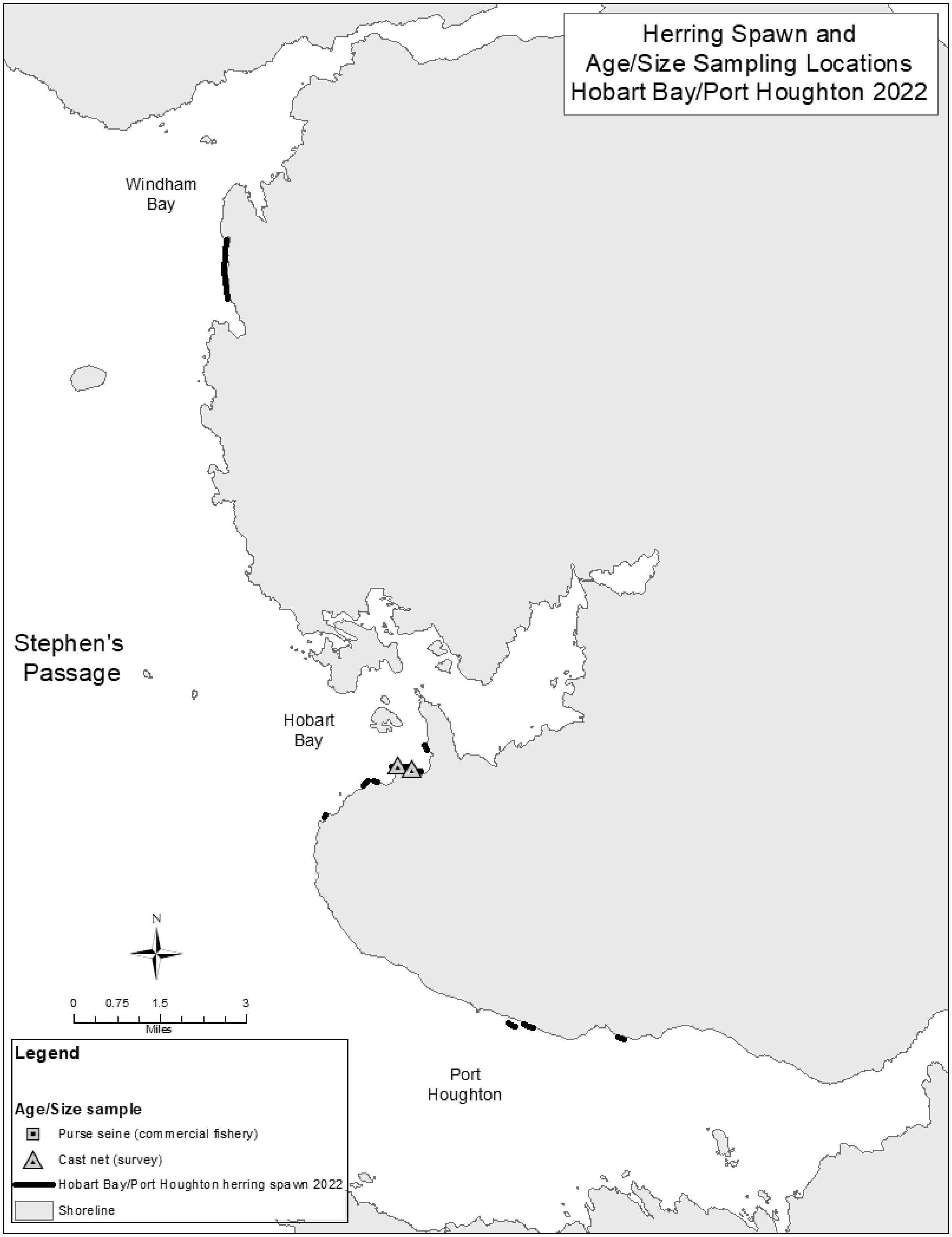

Figure 25.–Locations of herring observed for the Hobart Bay/Port Houghton herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

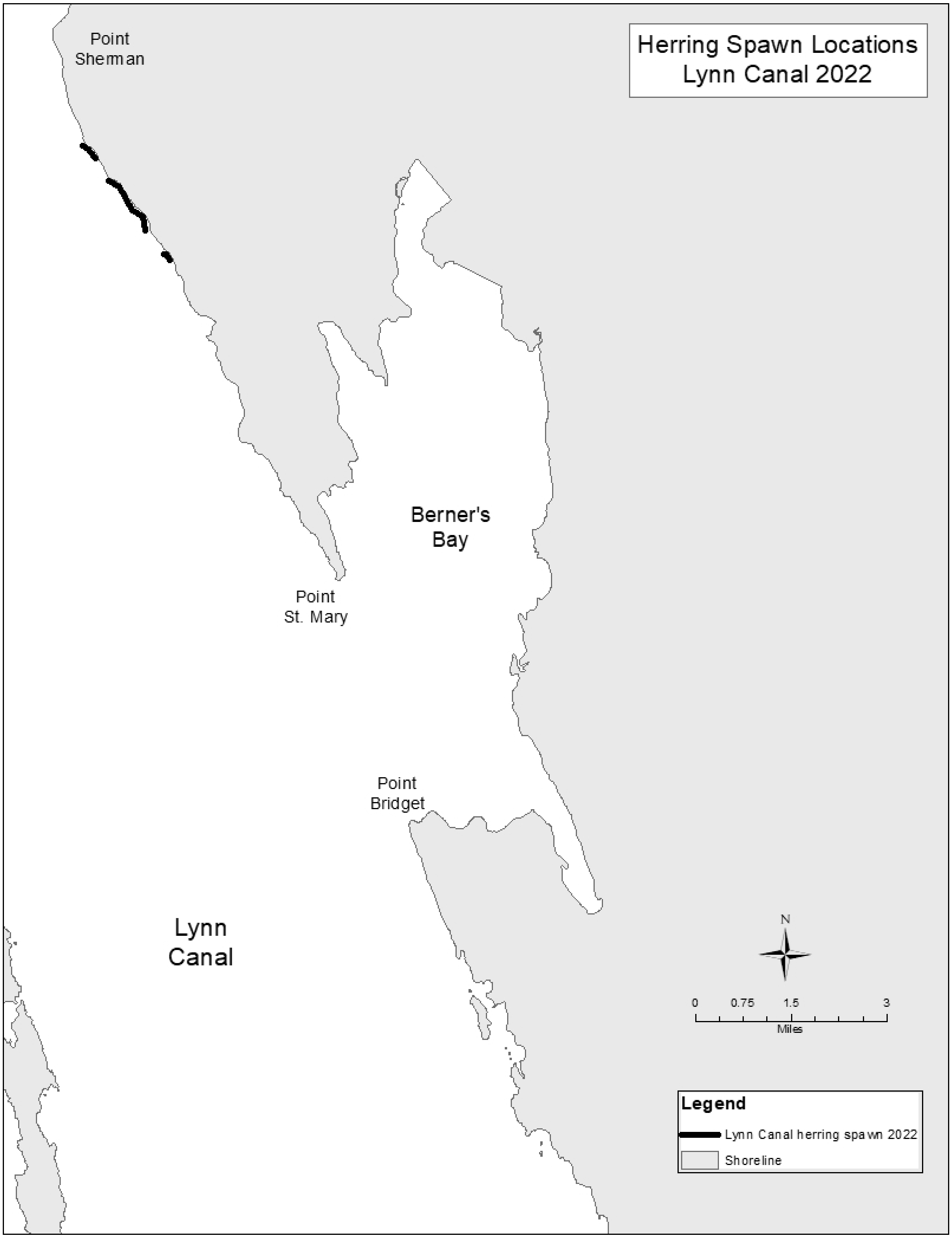

Figure 26.–Locations of herring observed for the Lynn Canal herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

Figure 27.–Locations of herring observed for the Tenakee Inlet herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline and was only observed near Point Hayes.

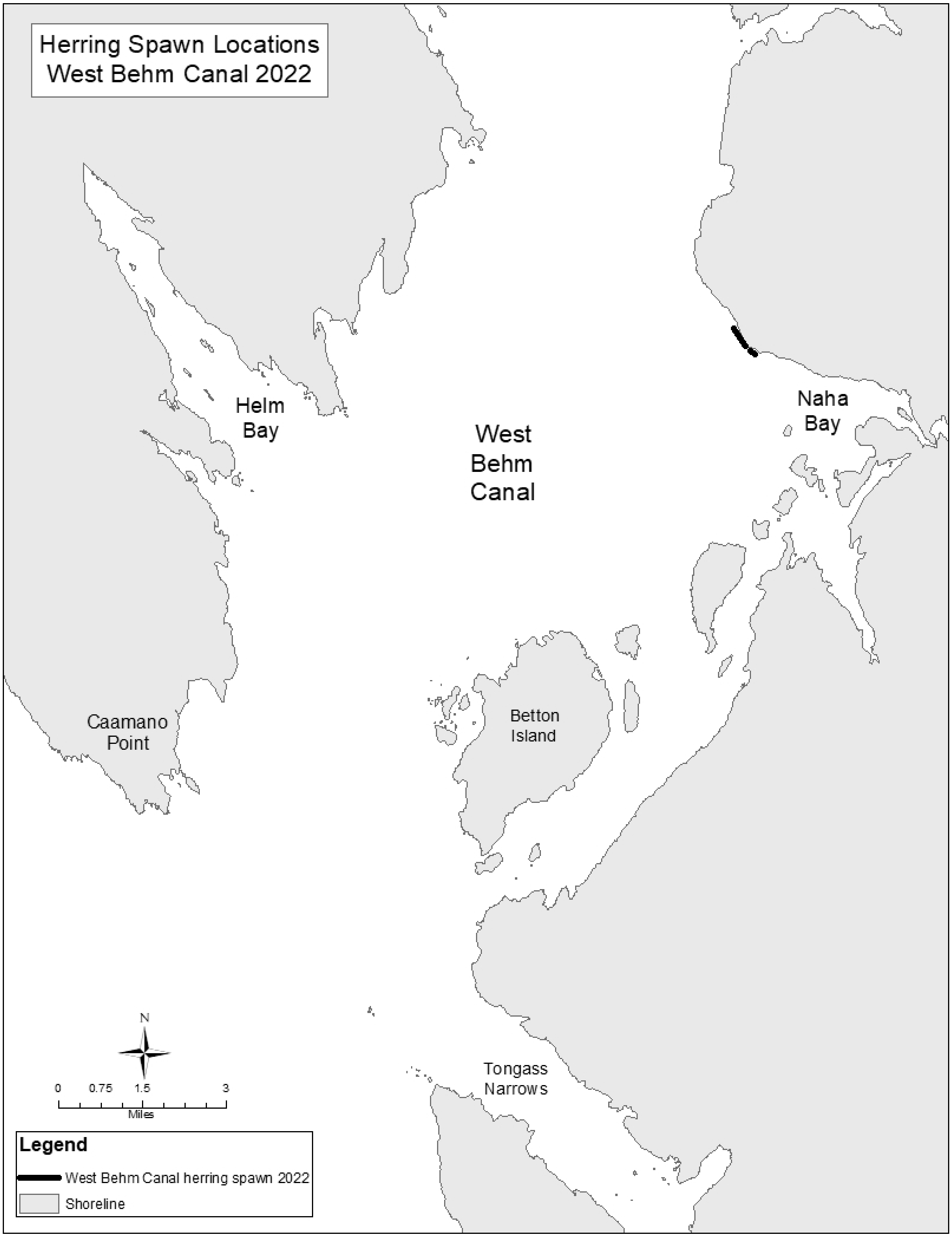

Figure 28.–Locations of herring observed for the West Behm Canal herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

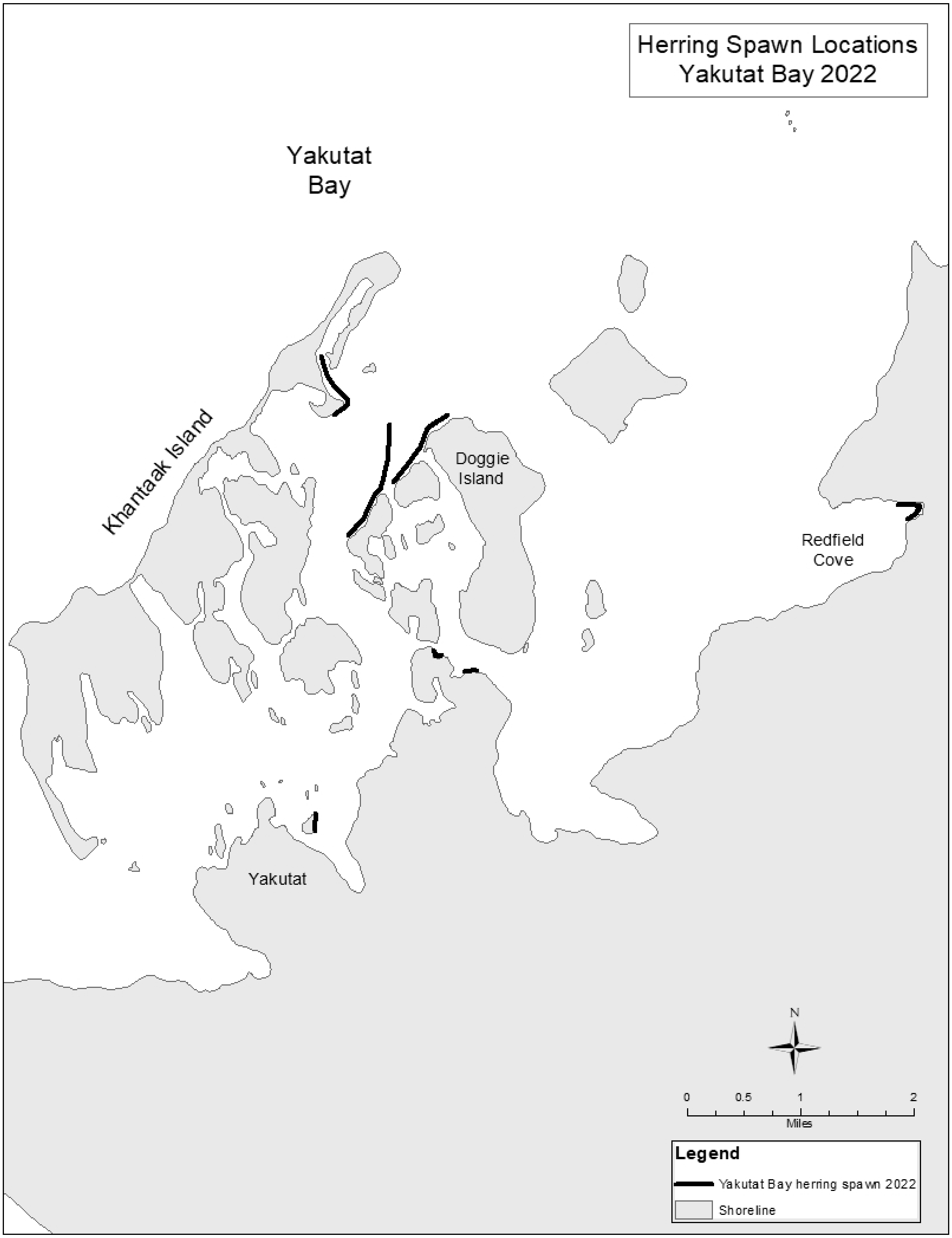

Figure 29.–Locations of herring observed for the Yakutat Bay herring stock for the 2021–2022 season. Cumulative herring spawn denoted by thick black line along shoreline.

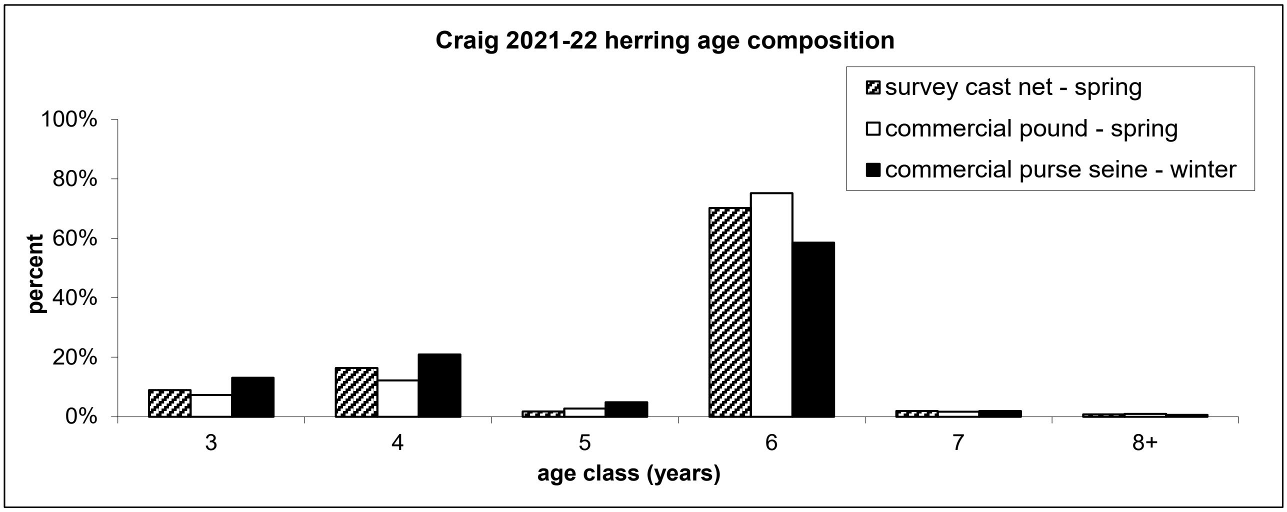

Figure 30.–Observed age composition for Craig herring stock in 2021–2022.

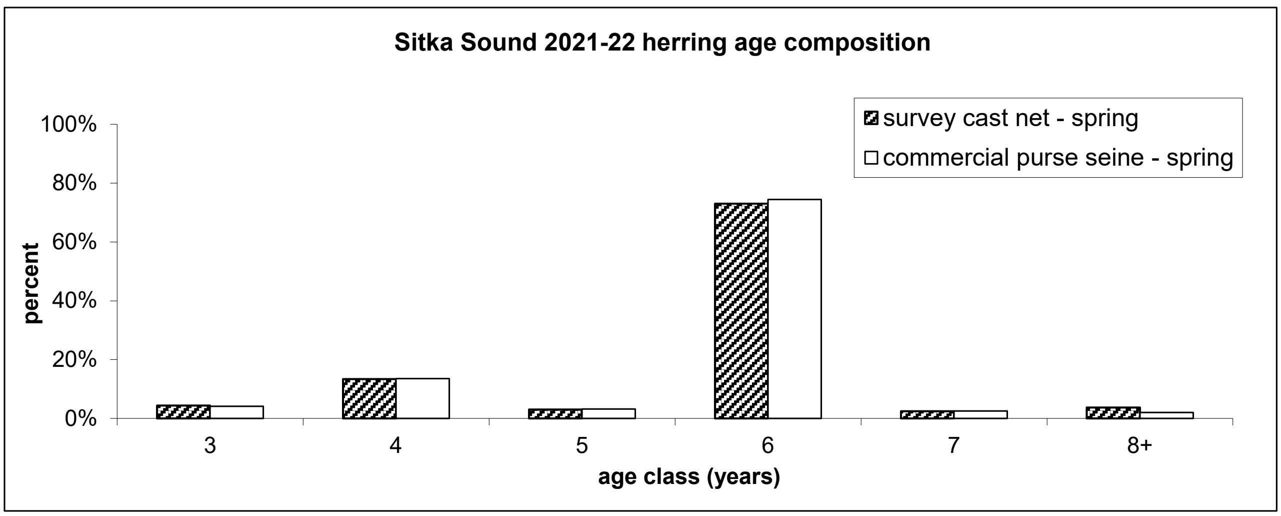

Figure 31.–Observed age composition for Sitka herring stock in 2021–2022.

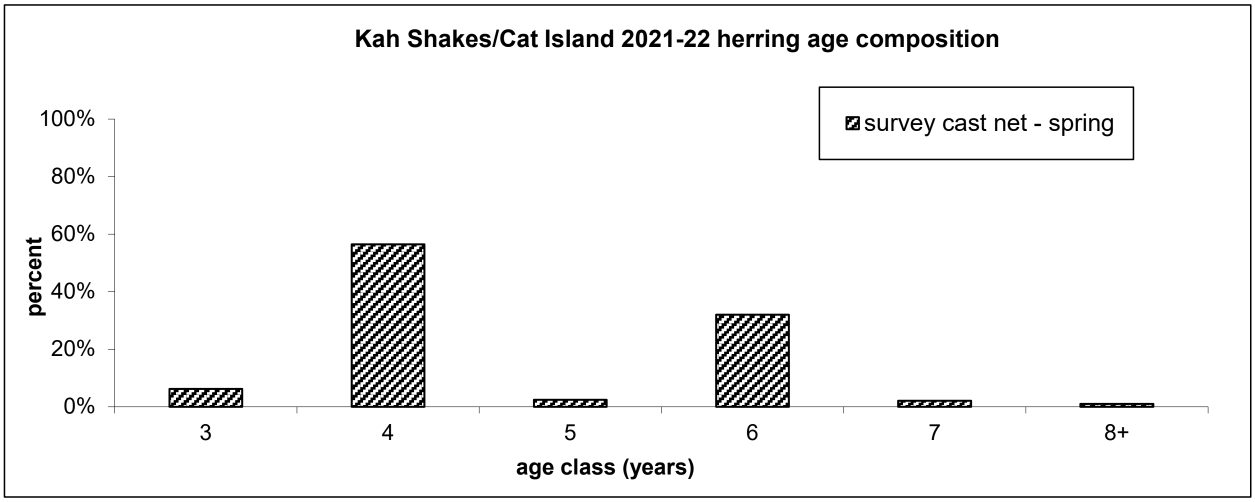

Figure 32.–Observed age composition for Kah Shakes–Cat Island (Revilla Channel) herring stock in 2021–2022.

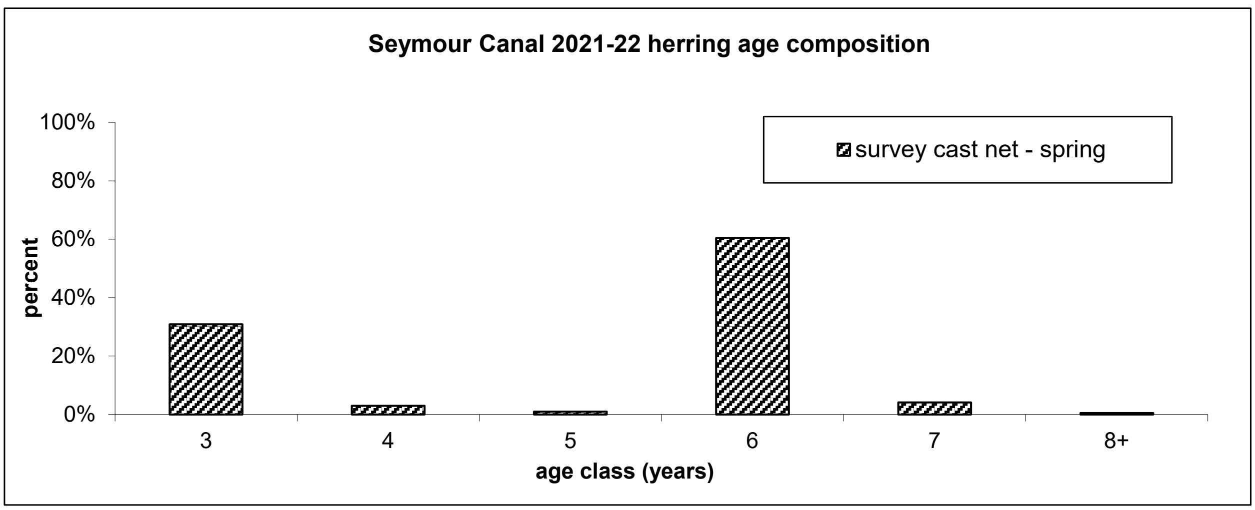

Figure 33.–Observed age composition for Seymour Canal herring stock in 2021–2022.

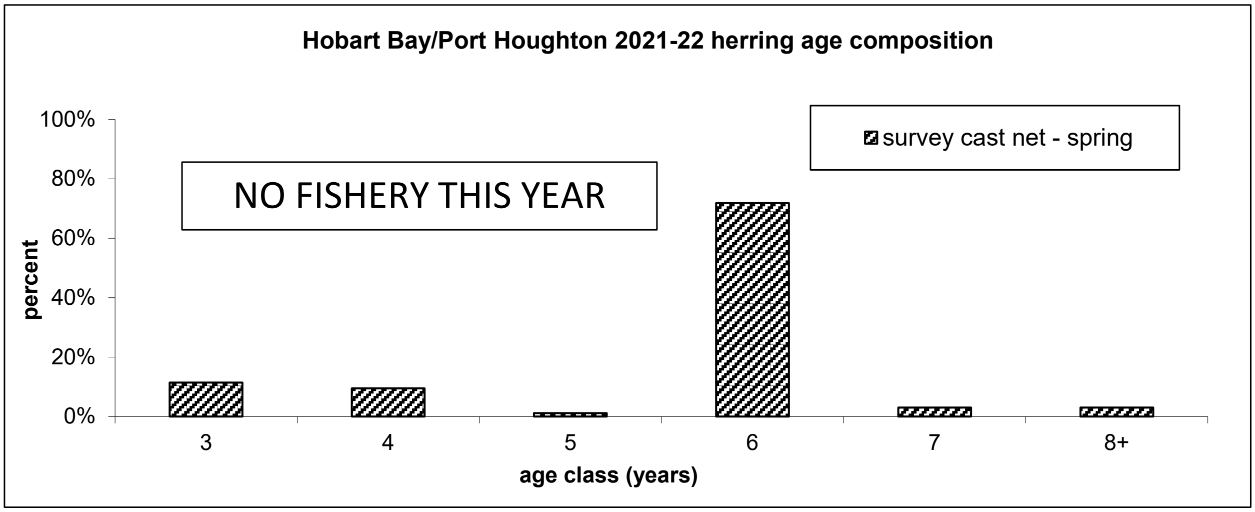

Figure 34.–Observed age composition for Hobart Bay/Port Houghton herring stock in 2021–2022. Sample size was 267 herring, which is below the minimum of 511 needed to meet the age composition precision goal.

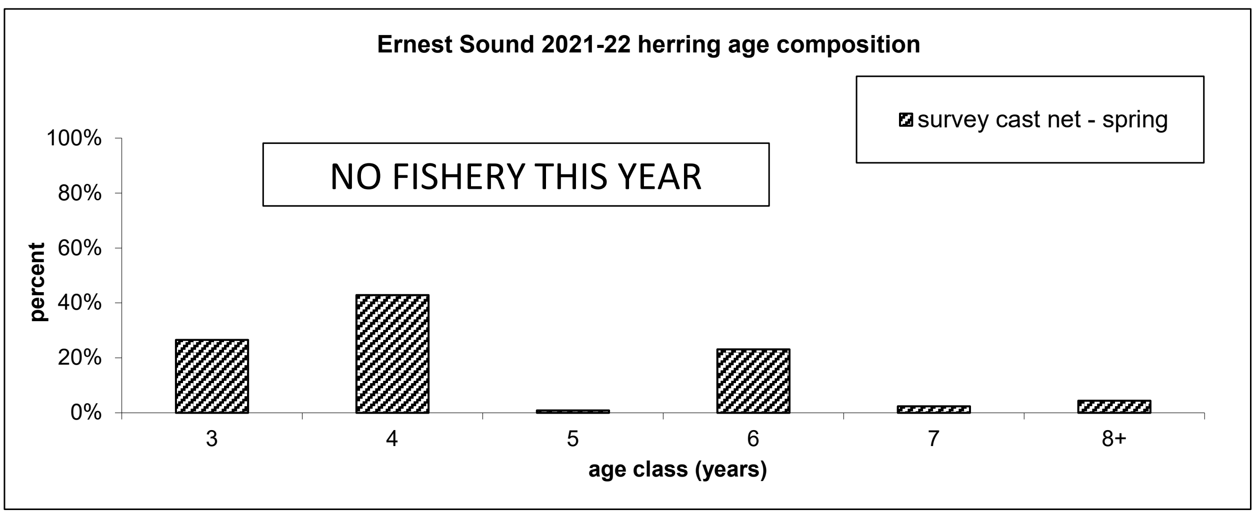

Figure 35.–Observed age composition for Ernest Sound herring stock in 2021–2022. Sample size was 363 herring, which is below the minimum of 511 needed to meet the age composition precision goal.

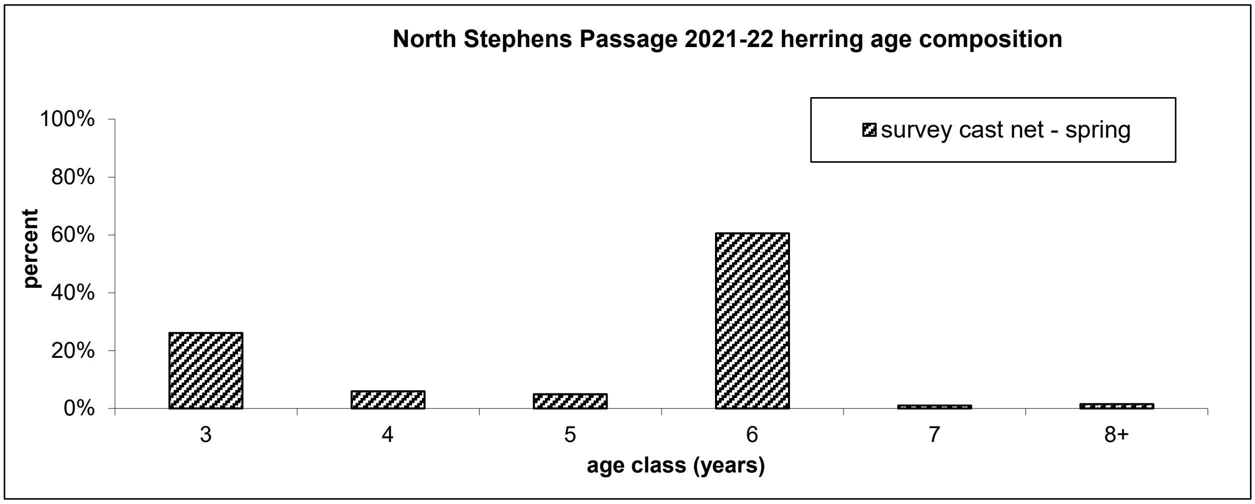

Figure 36.–Observed age composition for North Stephen’s Passage herring spawning area in 2021–2022.

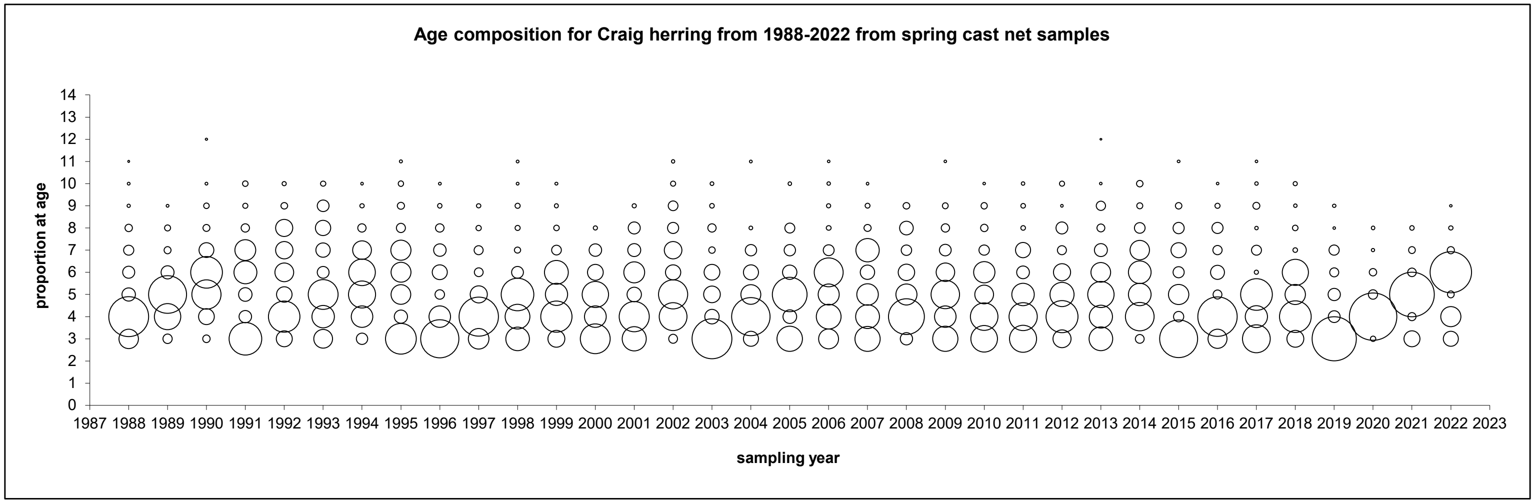

Figure 37.–Observed age compositions from sampling data for the Craig herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For reference, the largest circle represents 93% (2020).

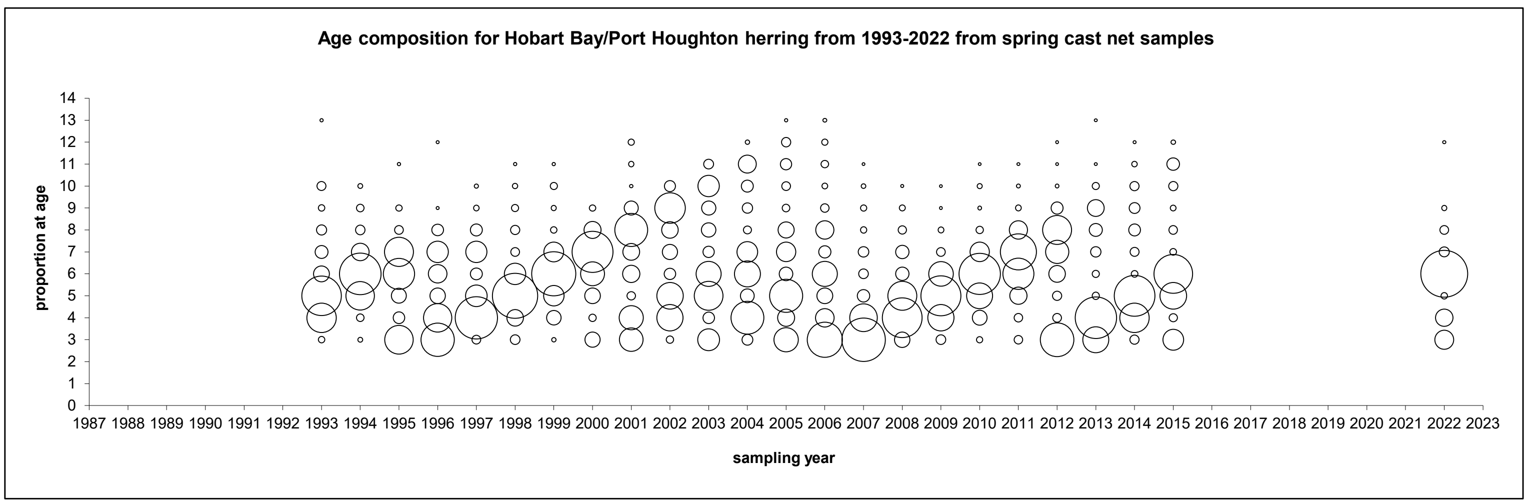

Figure 38.–Observed age compositions from sampling data for the Hobart Bay–Port Houghton herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available. For reference, the largest circle represents 72% (2022).

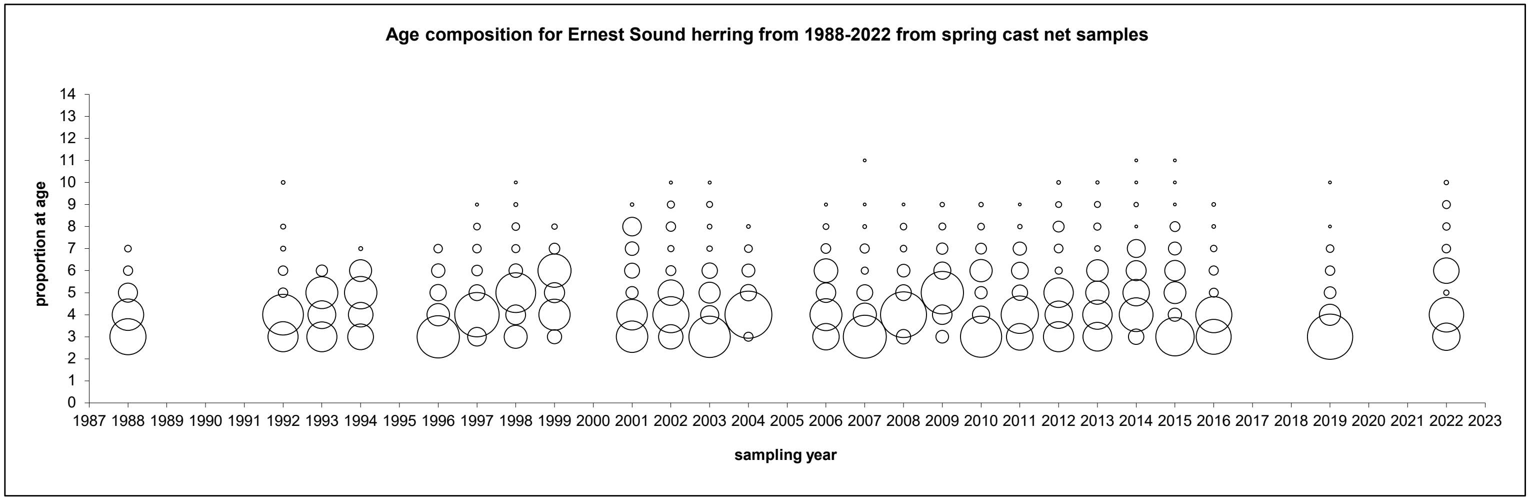

Figure 39.–Observed age compositions from sampling data for the Ernest Sound herring stock. For years with blanks, data were either not collected or were not available. For reference, the largest circle represents 80% (2004).

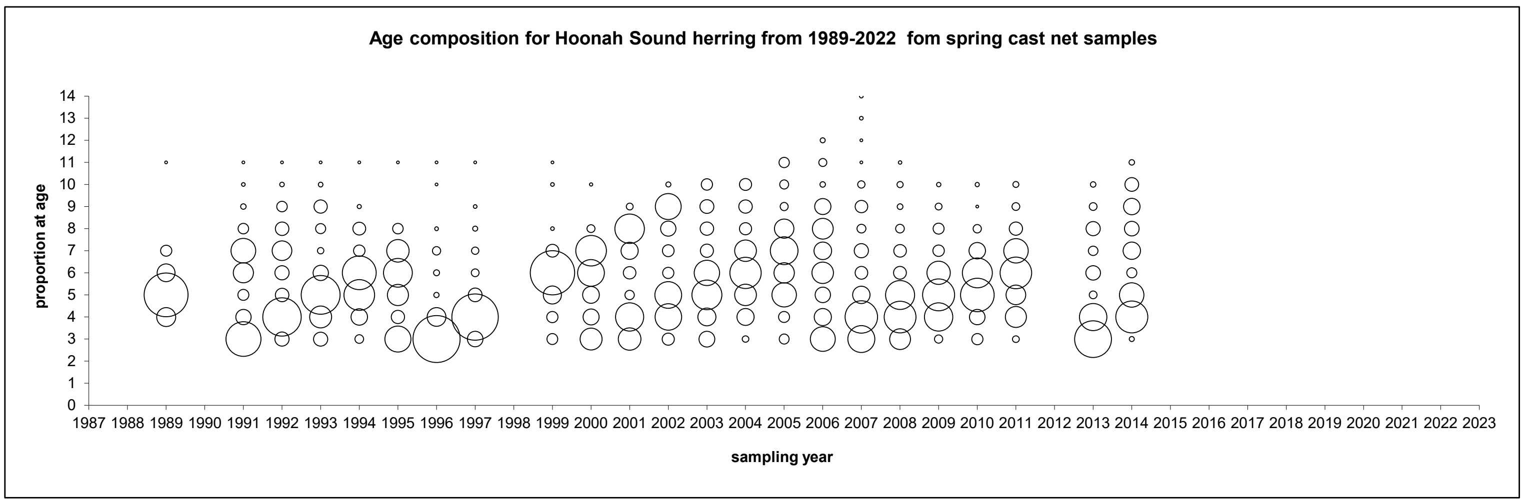

Figure 40.–Observed age compositions from sampling data for the Hoonah Sound herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available. For reference, the largest circle represents 82% (1996).

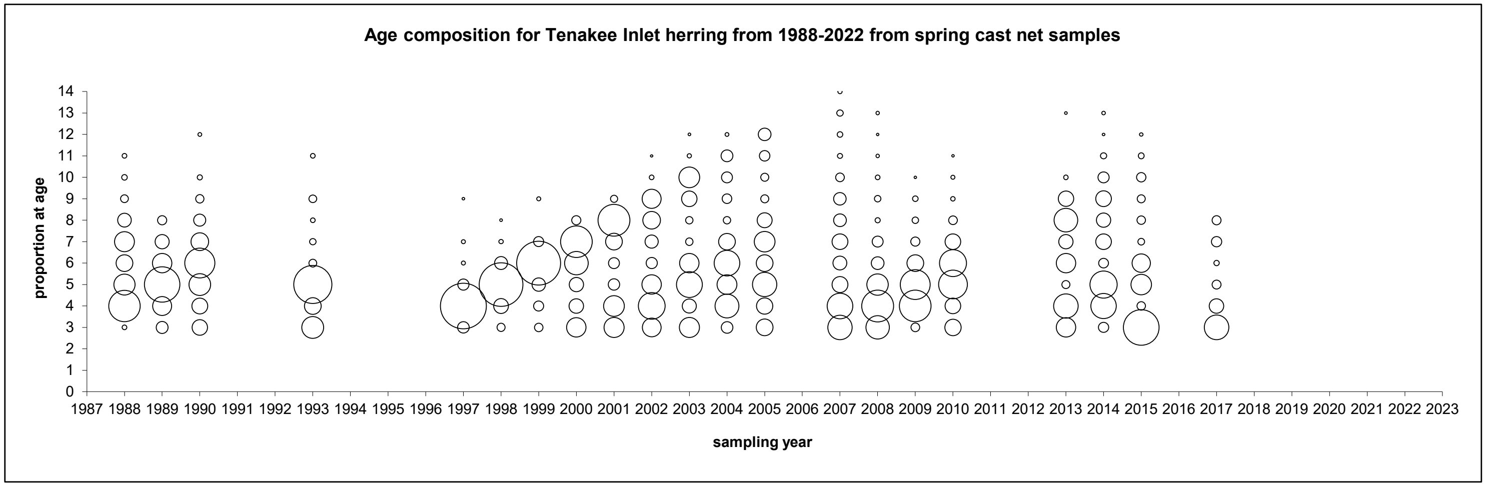

Figure 41.–Observed age compositions from sampling data for the Tenakee Inlet herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available. For reference, the largest circle represents 88% (1997).

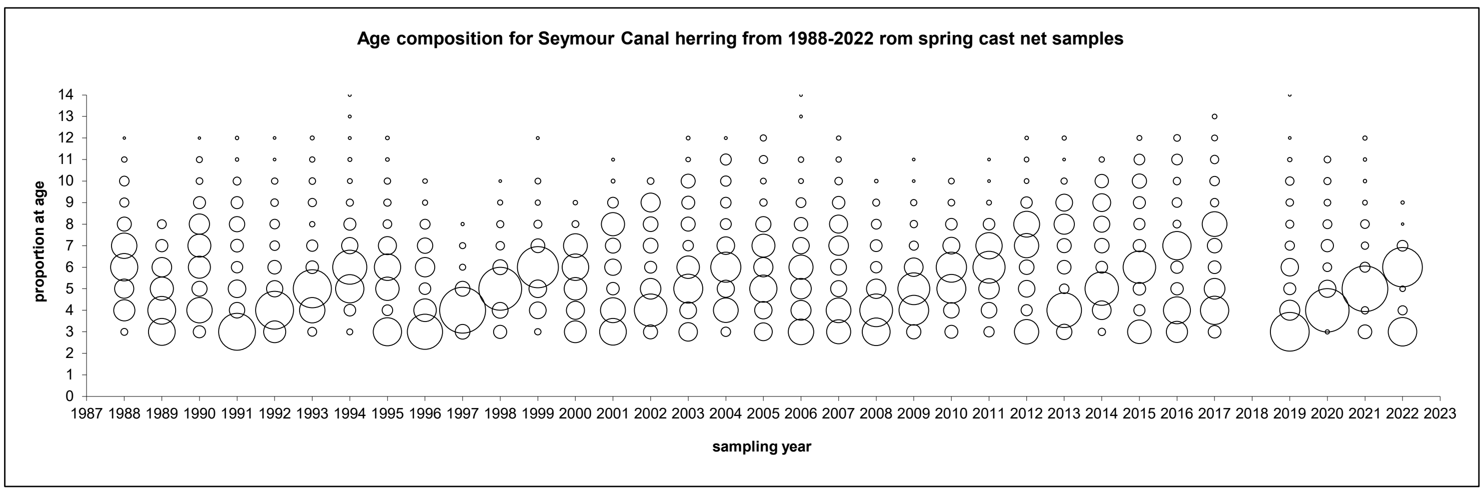

Figure 42.–Observed age compositions from sampling data for the Seymour Canal herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available. For reference, the largest circle represents 81% (2021 and 1997).

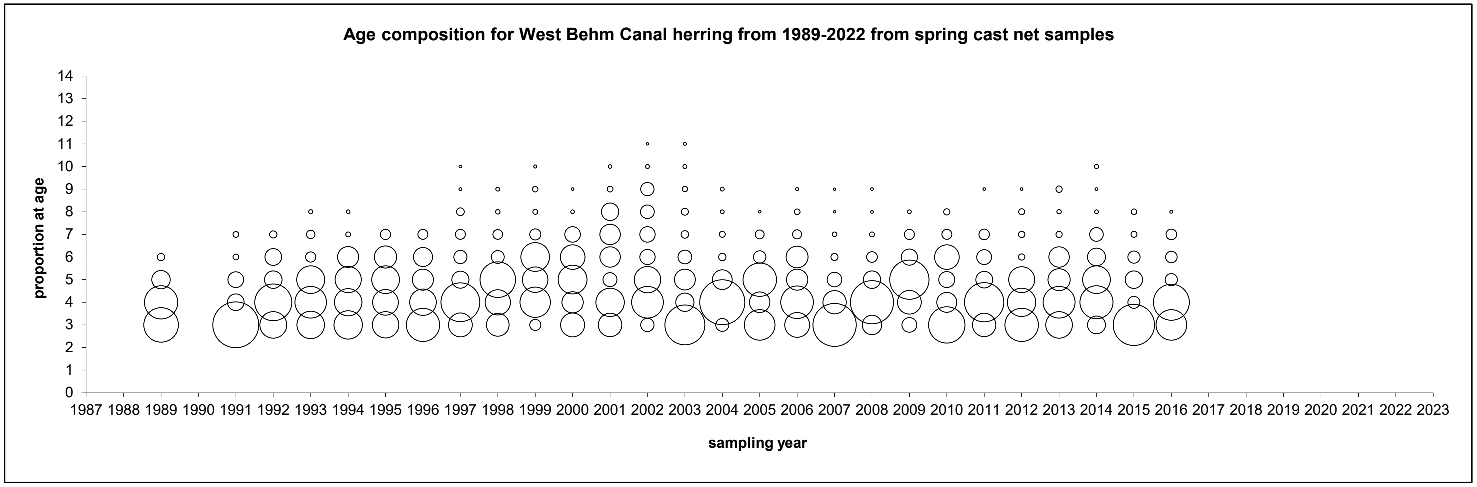

Figure 43.–Observed age compositions from sampling data for the West Behm Canal herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available. For reference, the largest circle represents 79% (1991).

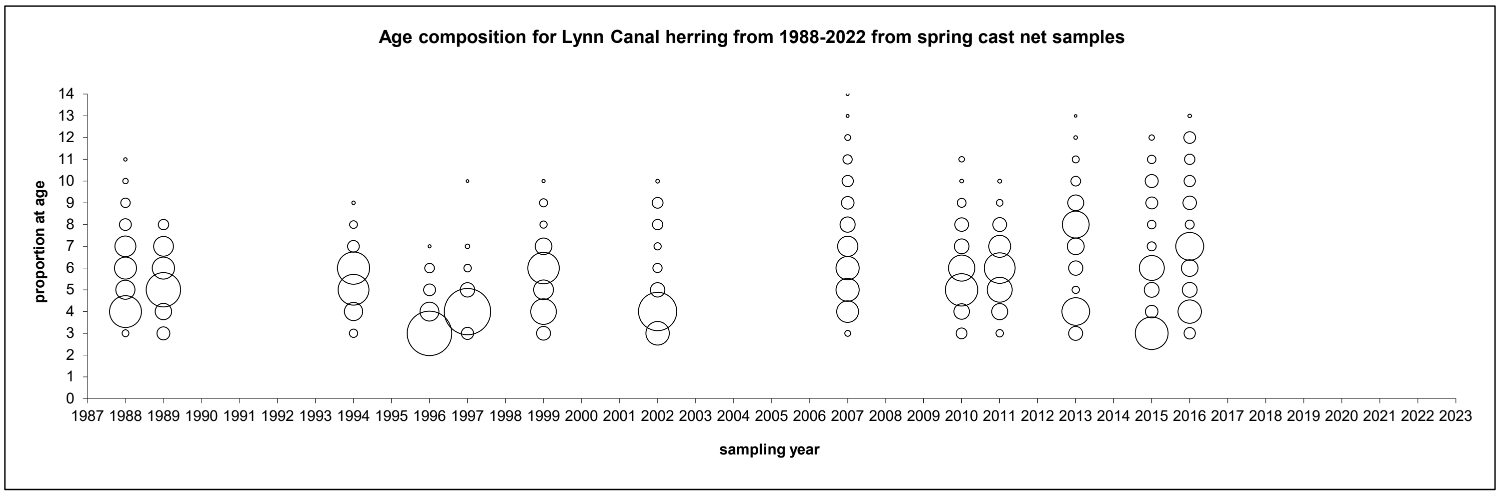

Figure 44.–Observed age compositions from sampling data for the Lynn Canal herring stock. For years with blanks, data were either not collected or were not available. For reference, the largest circle represents 84% (1997).

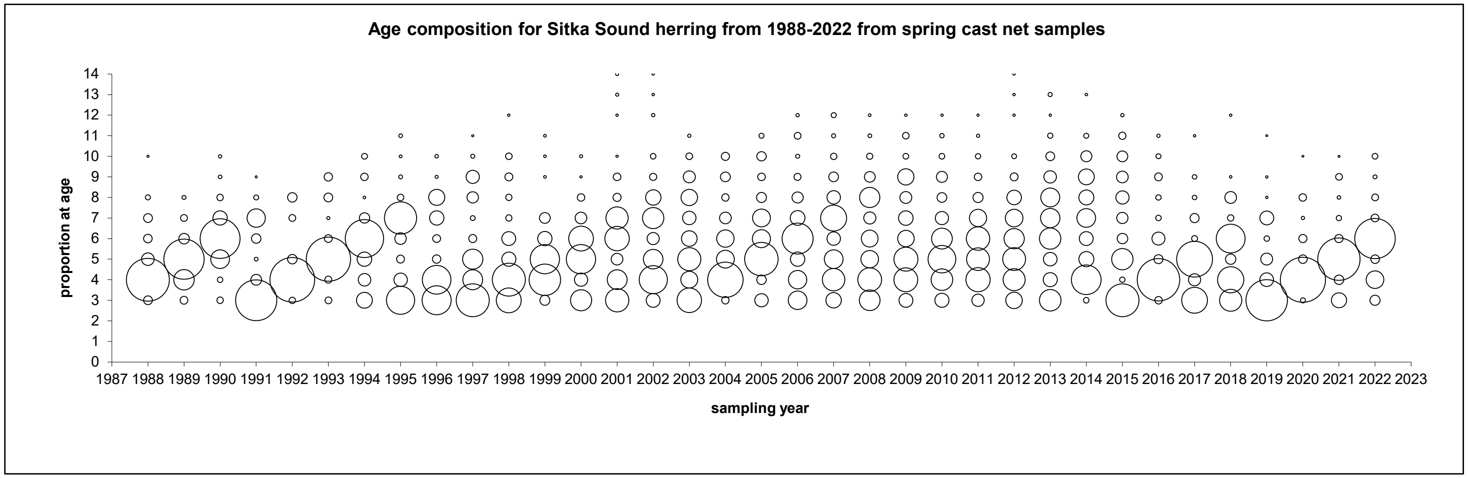

Figure 45.–Observed age compositions from sampling data for the Sitka Sound herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For reference, the largest circle represents 91% (2022).

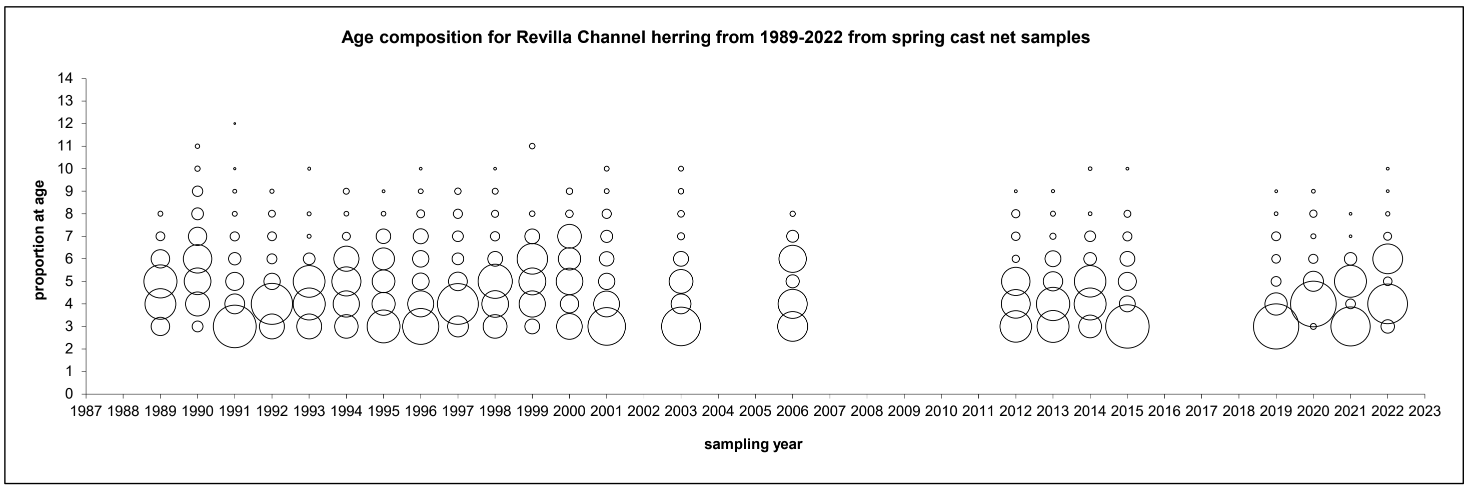

Figure 46.–Observed age compositions from sampling data for the Kah Shakes–Cat Island (Revilla Channel) herring stock. Ages presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available. For reference, the largest circle represents 75% (2020).

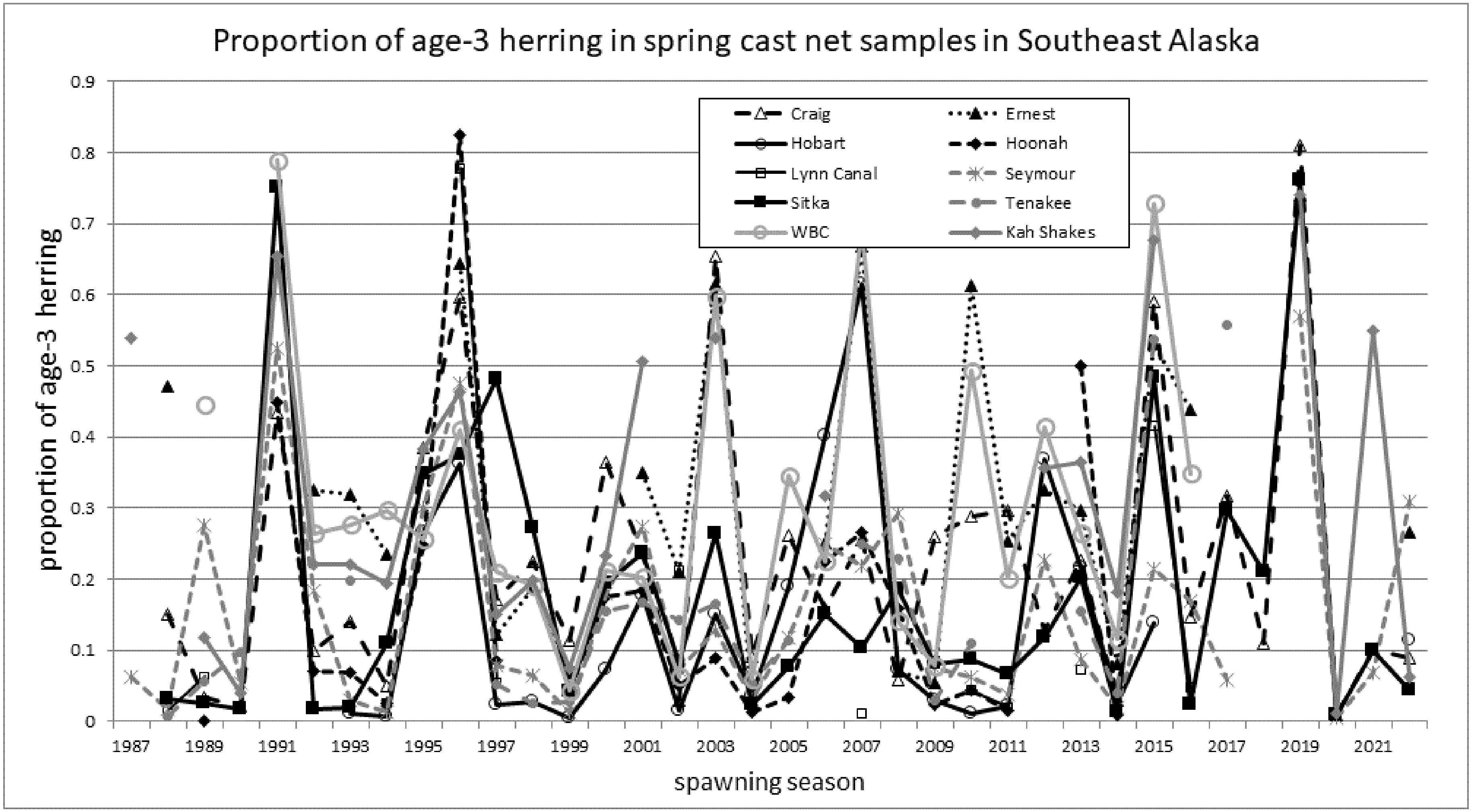

Figure 47.–Proportions of observed age-3 herring in spring cast nest samples of spawning populations for stocks in Southeast Alaska.

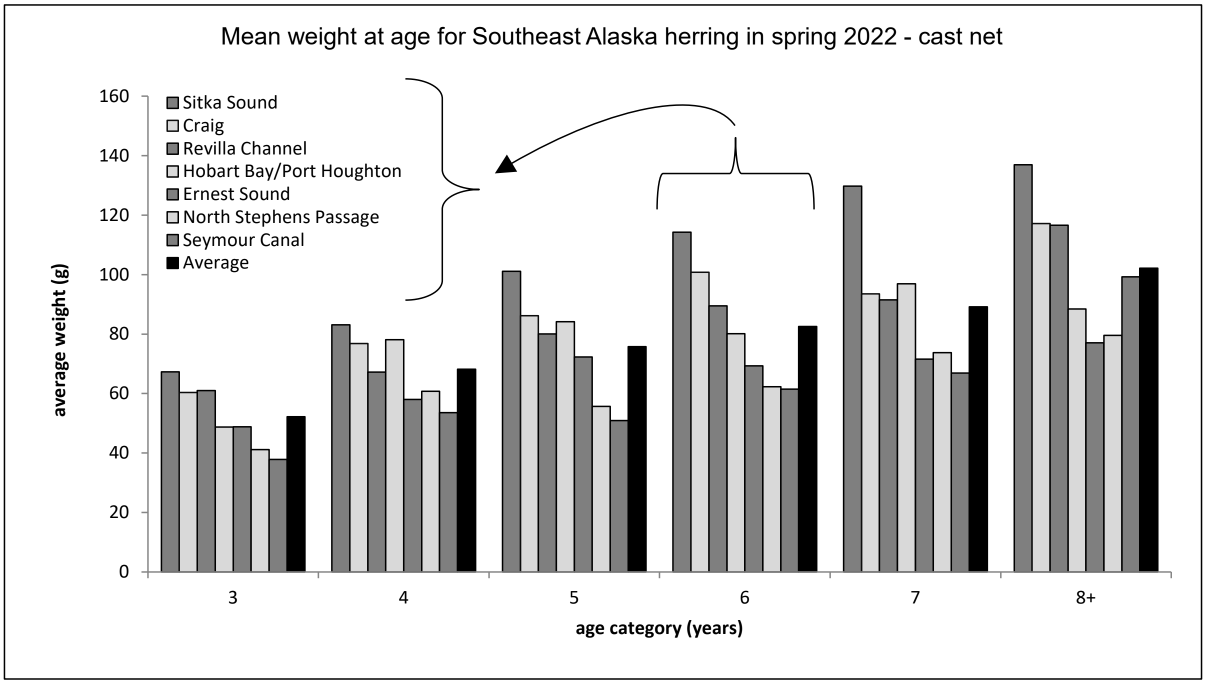

Figure 48.–Mean observed weight-at-age for Southeast Alaska herring stocks surveyed in spring 2022, sorted by age-6. The order of bars within age (left to right) is the order of the list of stocks and shade of bars is only to aid in visual separation of stocks.

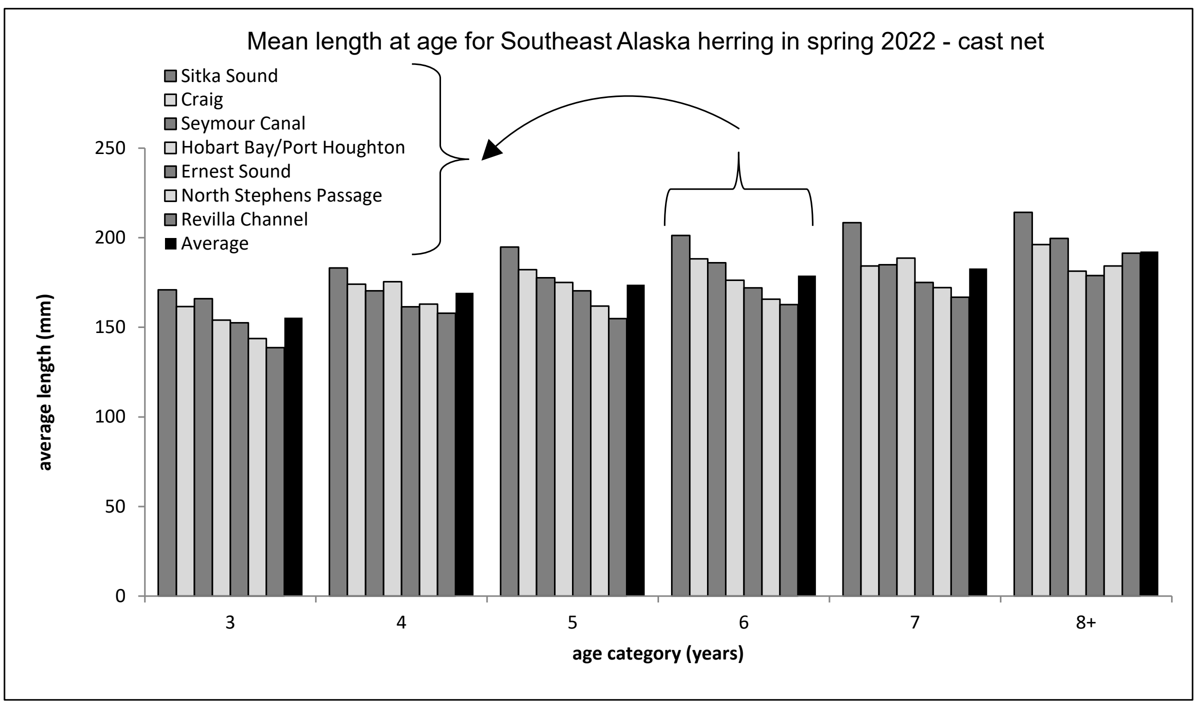

Figure 49.–Mean observed length-at-age for Southeast Alaska herring stocks surveyed in spring 2022, sorted by age-6. The order of bars within age (left to right) is the order of the list of stocks and shade of bars is only to aid in visual separation of stocks.

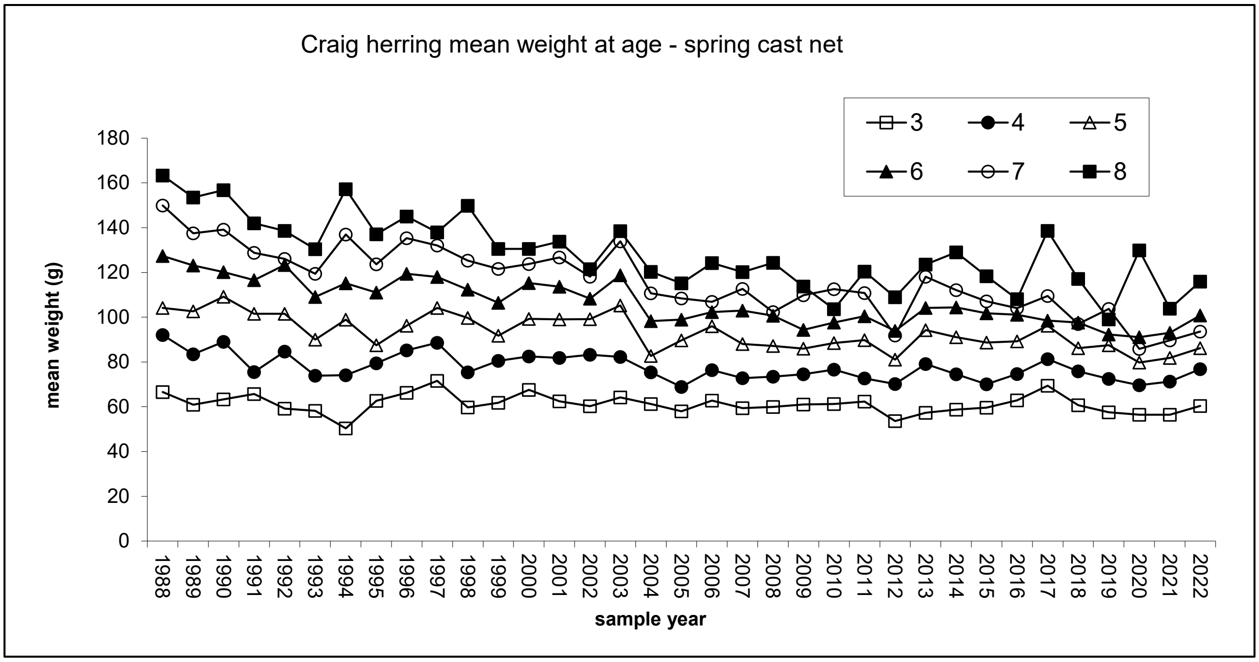

Figure 50.–Mean observed weight-at-age of the Craig herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

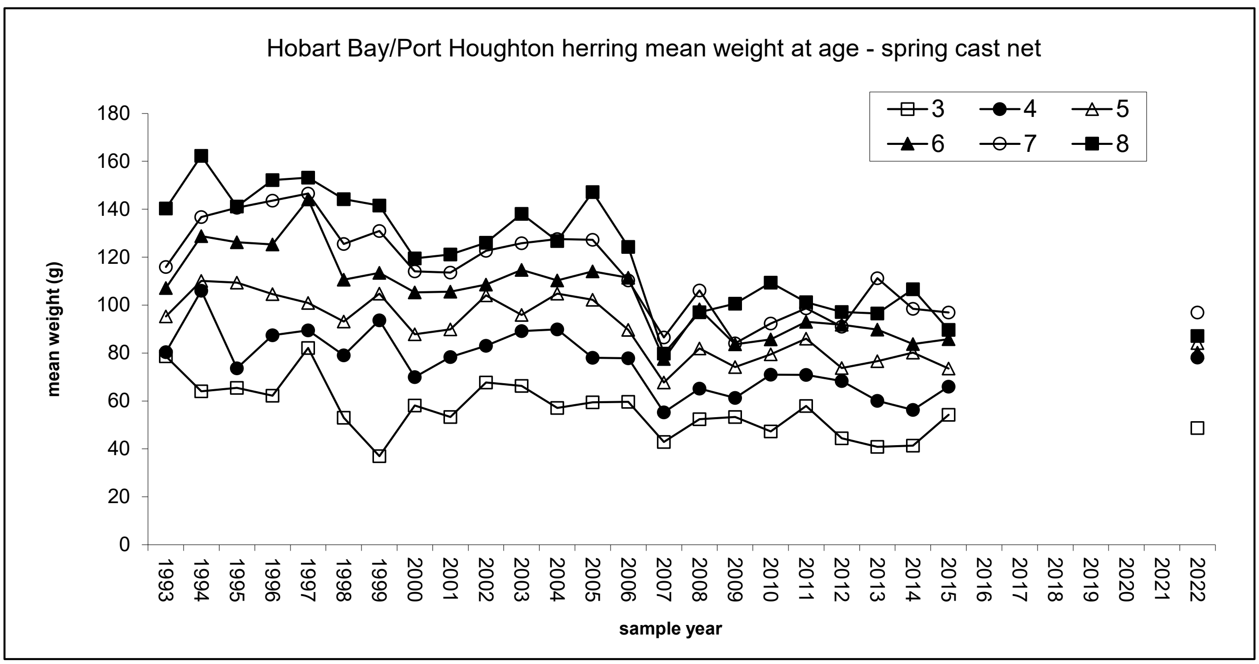

Figure 51.–Mean observed weight-at-age of the Hobart Bay–Port Houghton herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available.

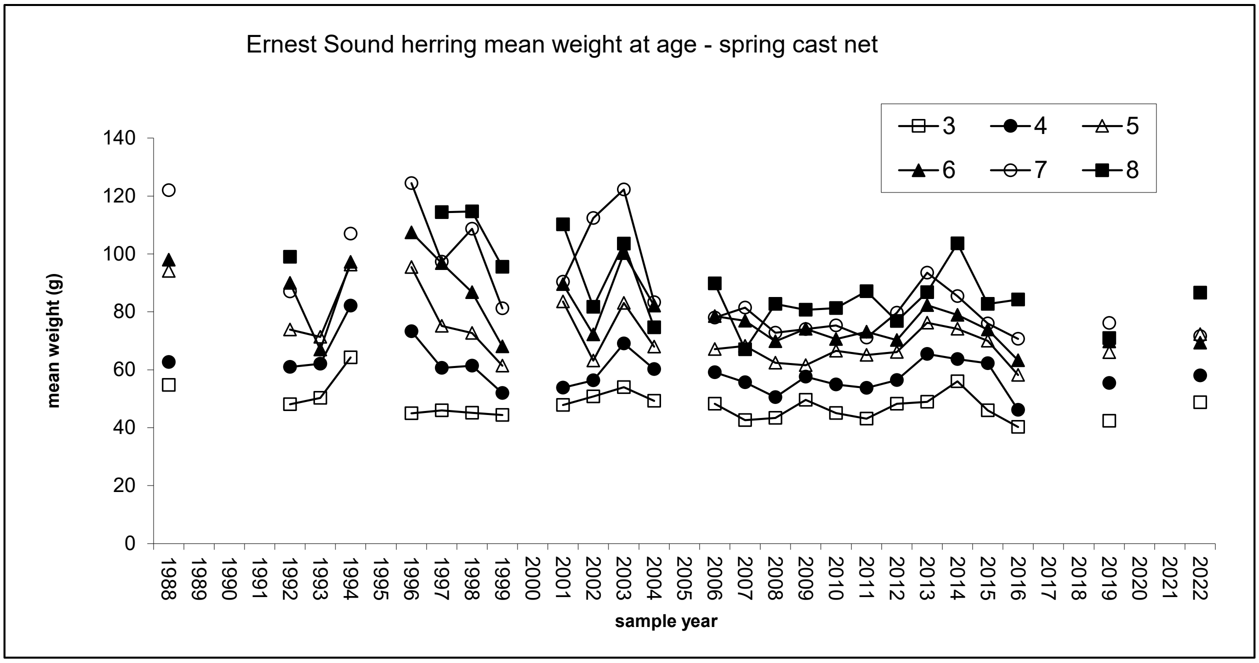

Figure 52.–Mean observed weight-at-age for the Ernest Sound herring spawning population. For years with blanks, data were either not collected or were not available.

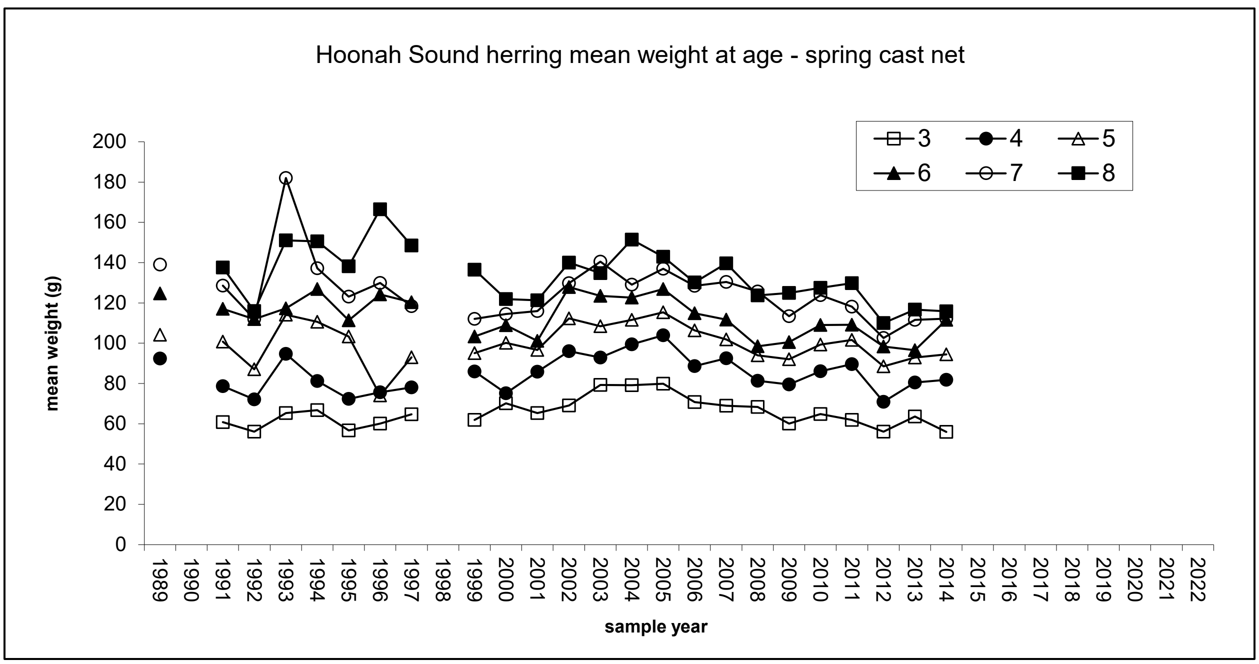

Figure 53.–Mean observed weight-at-age for the Hoonah Sound herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available.

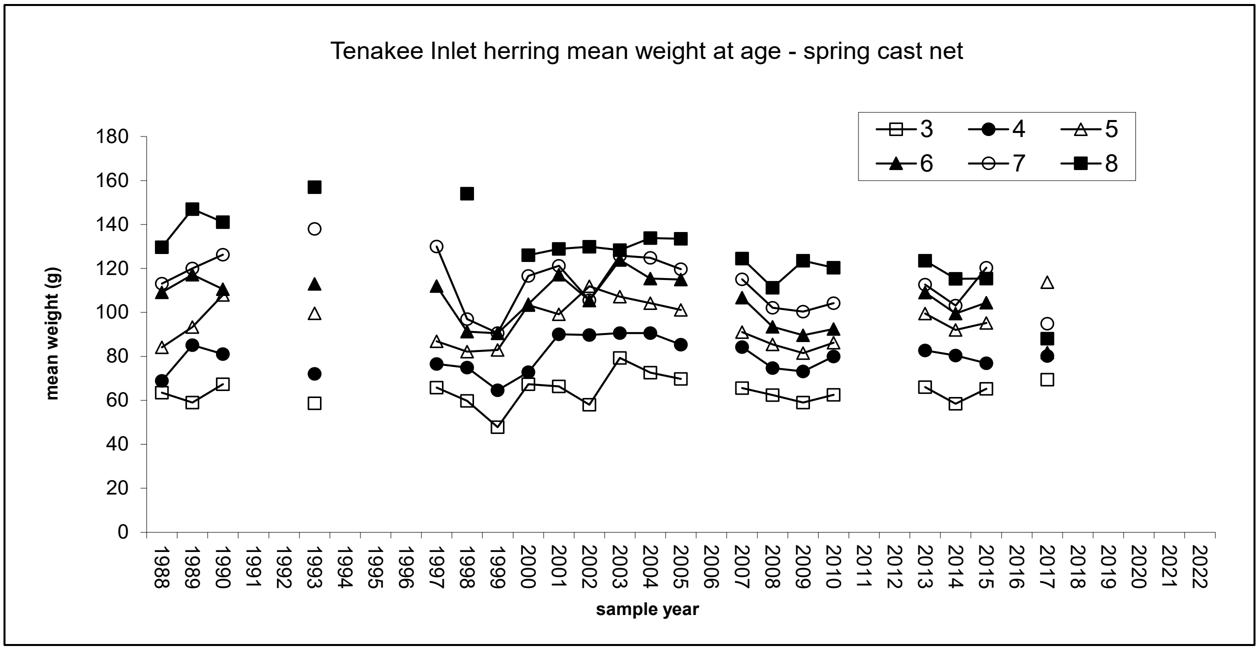

Figure 54.–Mean observed weight-at-age for the Tenakee Inlet herring stock. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available.

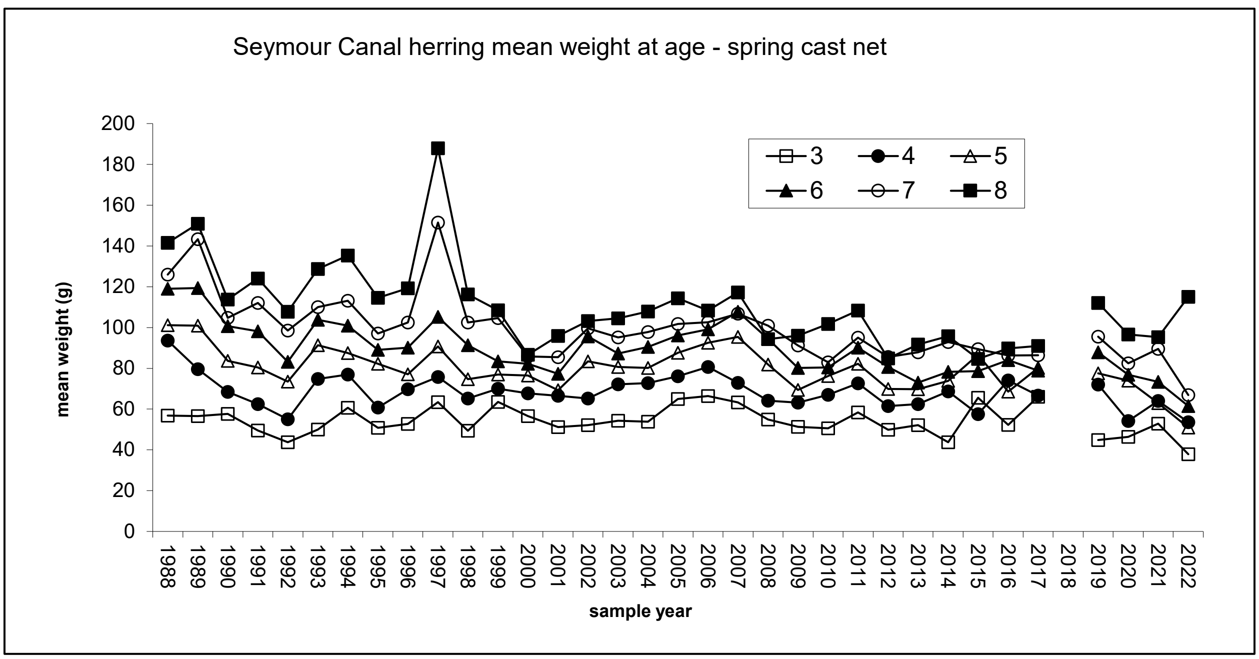

Figure 55.–Mean observed weight-at-age for the Seymour Canal herring stock. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available.

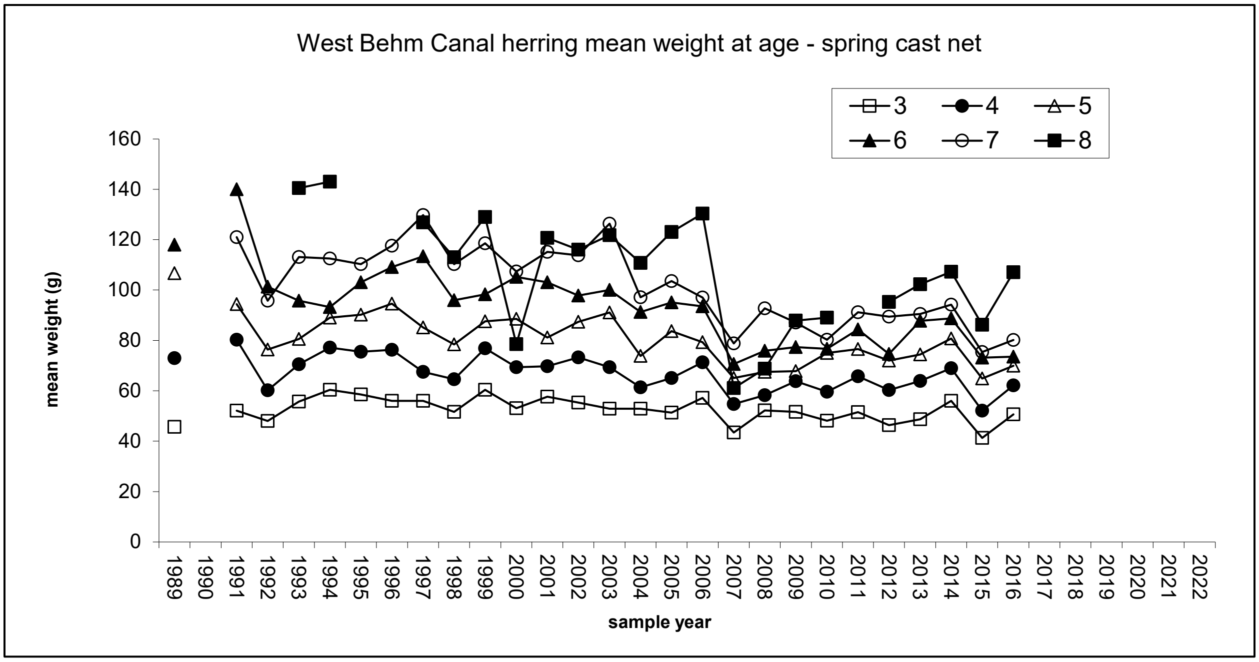

Figure 56.–Mean observed weight-at-age for the West Behm Canal herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. 2015 weights are likely biased low due to required additional sample handling that resulted in loss of weight. For years with blanks, data were either not collected or were not available.

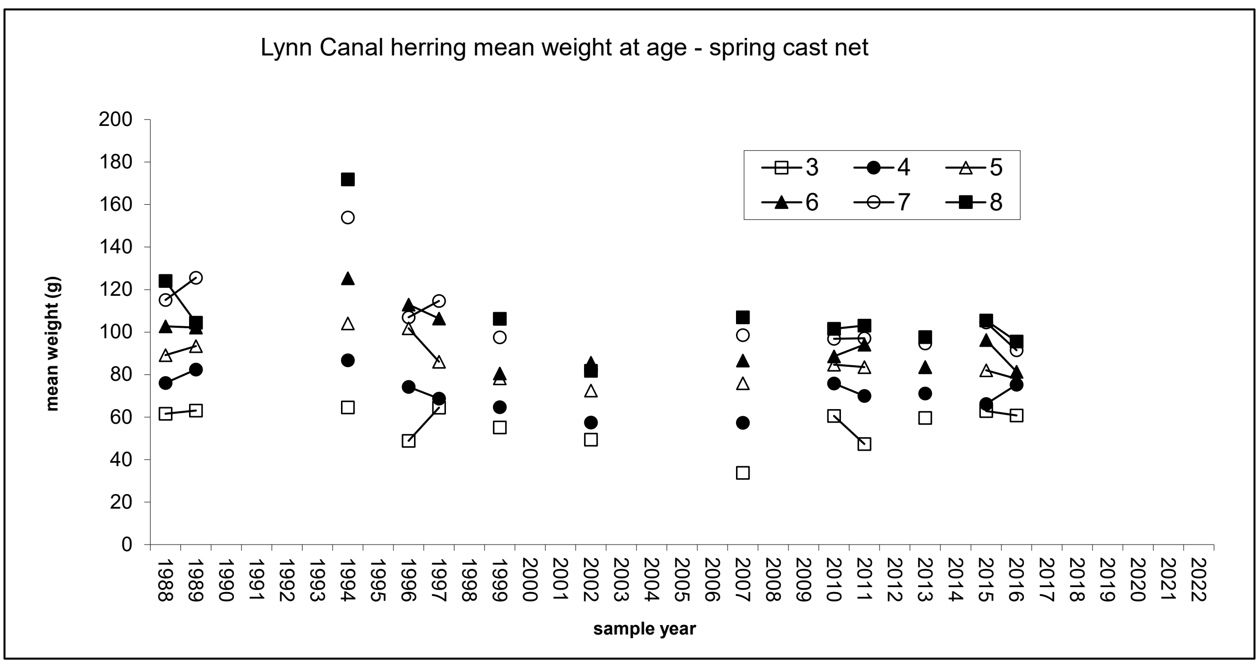

Figure 57.–Mean observed weight-at-age for the Lynn Canal herring spawning population. For years with blanks, data were either not collected or were not available.

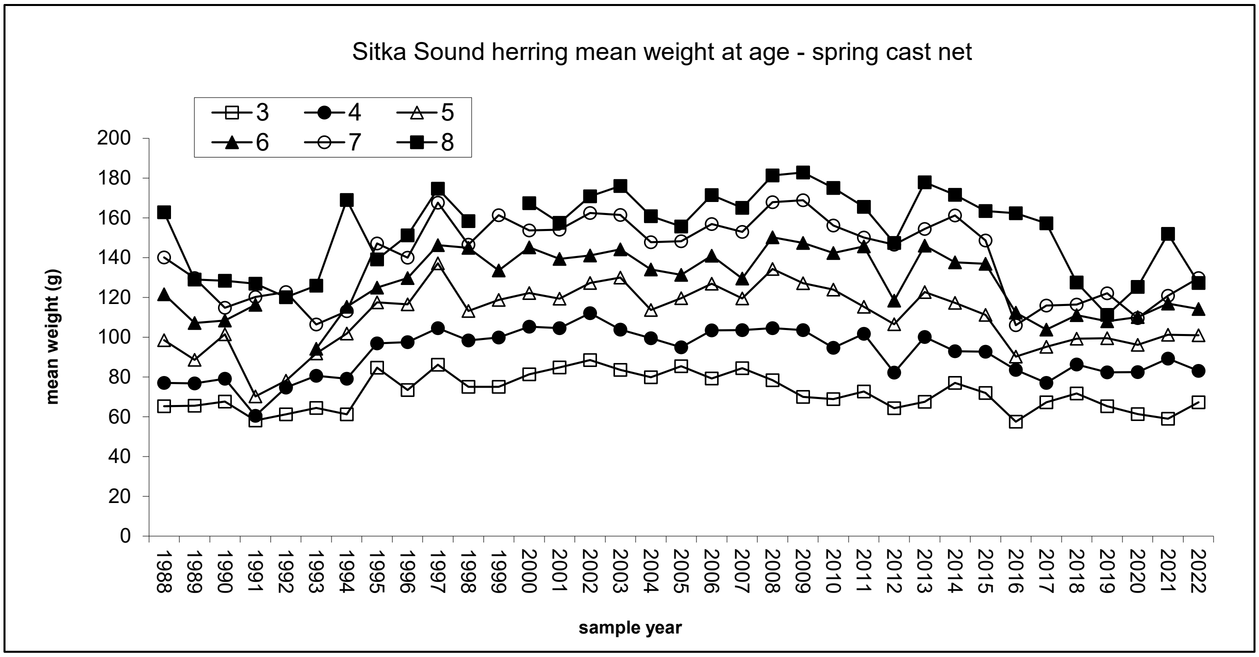

Figure 58.–Mean observed weight-at-age for the Sitka Sound herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli.

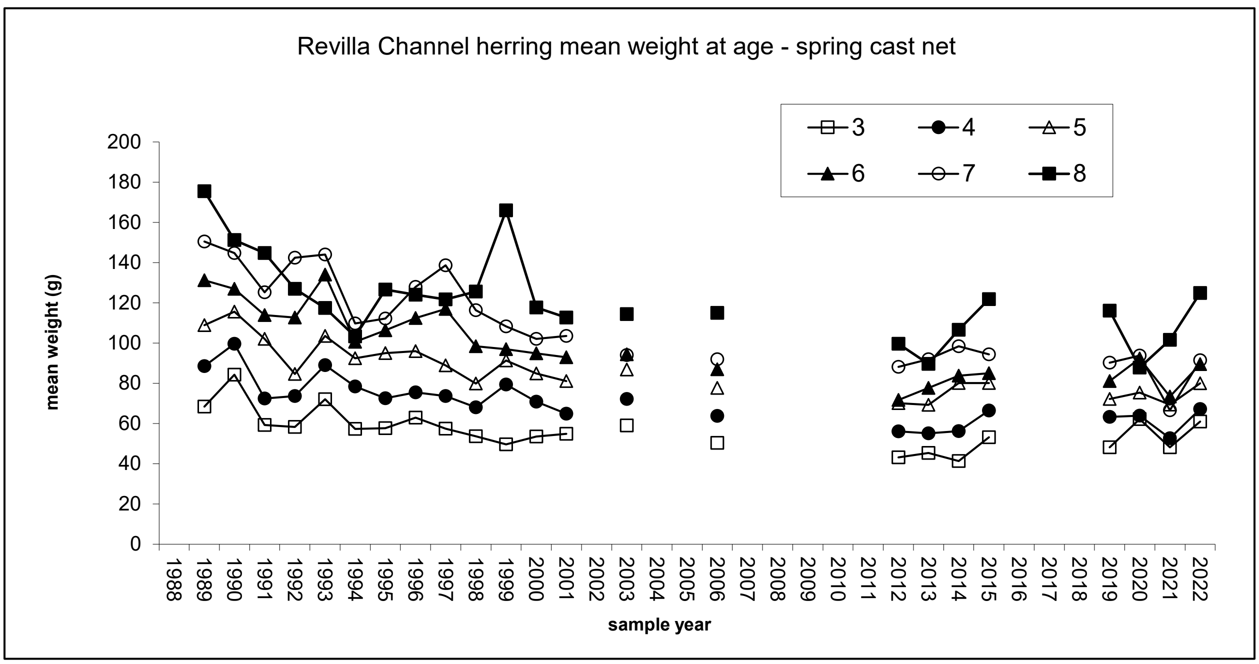

Figure 59.–Mean observed weight-at-age for the Revilla Channel herring spawning population. Weights presented for 2000 may be biased slightly high due to misinterpretation of scale annuli. For years with blanks, data were either not collected or were not available.

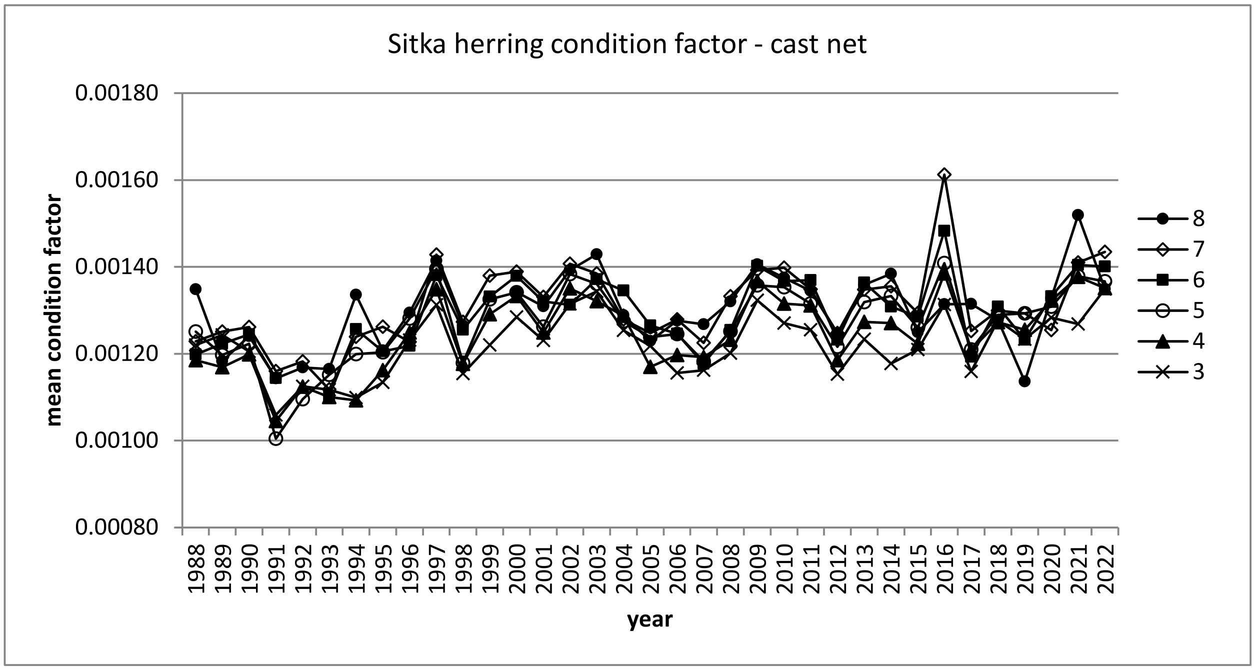

Figure 60.–Mean condition factors of age-3 through age-8 herring for the Sitka Sound spawning population, based on spring cast net samples taken during active spawning. 2016 values may be biased high due to length measurements that were likely underestimated.

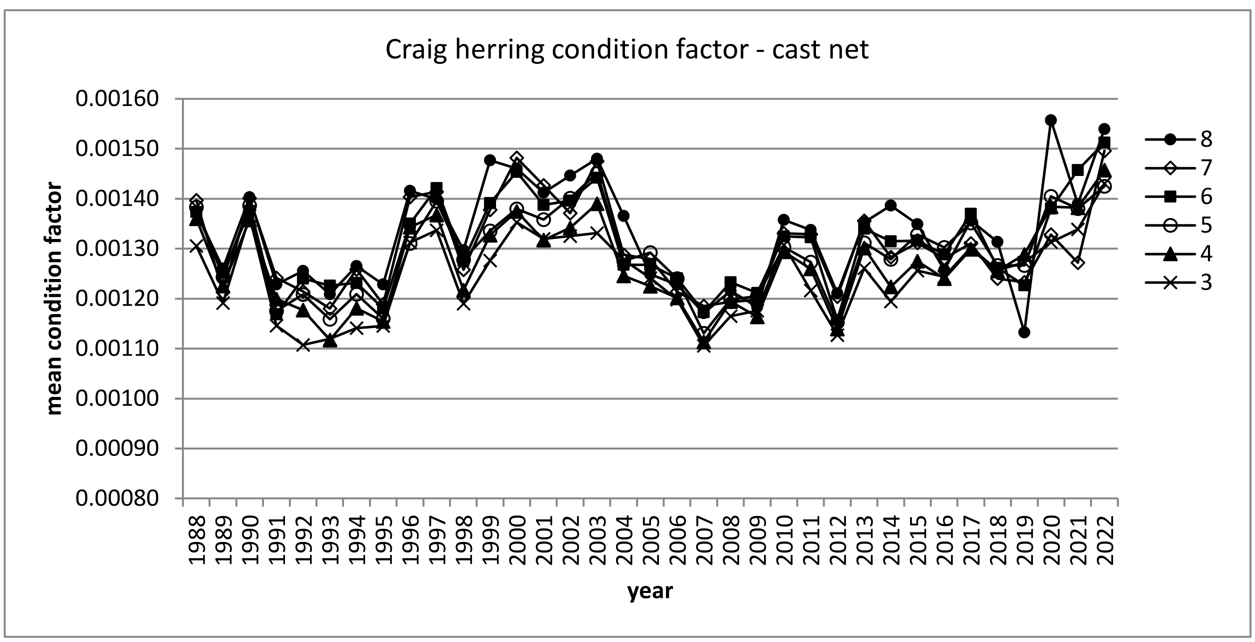

Figure 61.–Mean condition factors of age-3 through age-8 herring for the Craig spawning population, based on spring cast net samples taken during active spawning.

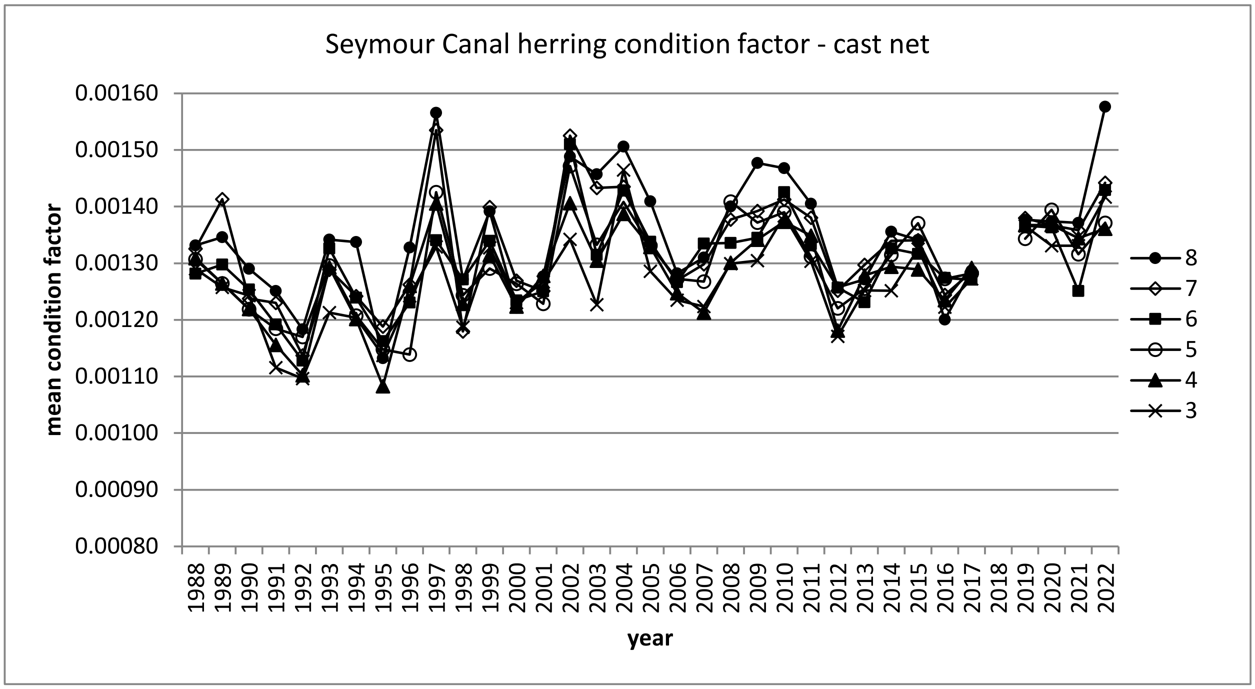

Figure 62.–Mean condition factors of age-3 through age-8 herring for the Seymour Canal spawning population, based on spring cast net samples taken during active spawning.

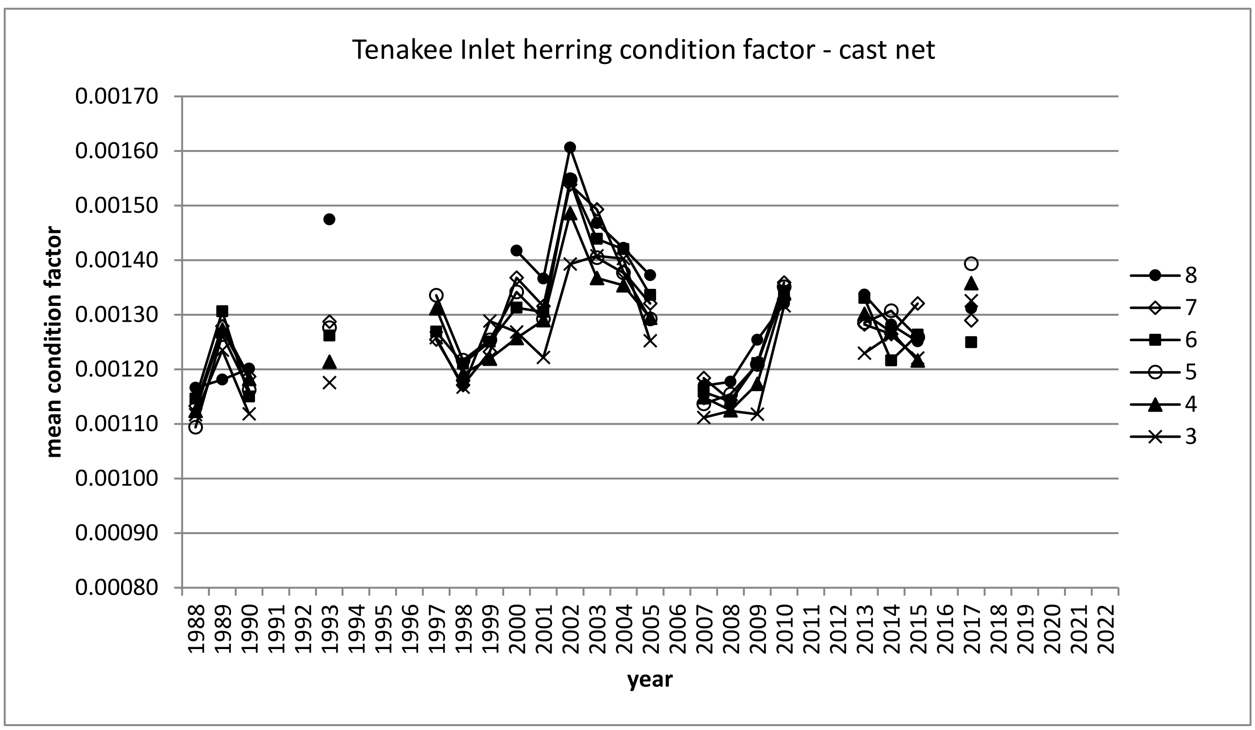

Figure 63.–Mean condition factors of age-3 through age-8 herring for the Tenakee Inlet spawning population, based on spring cast net samples taken during active spawning.

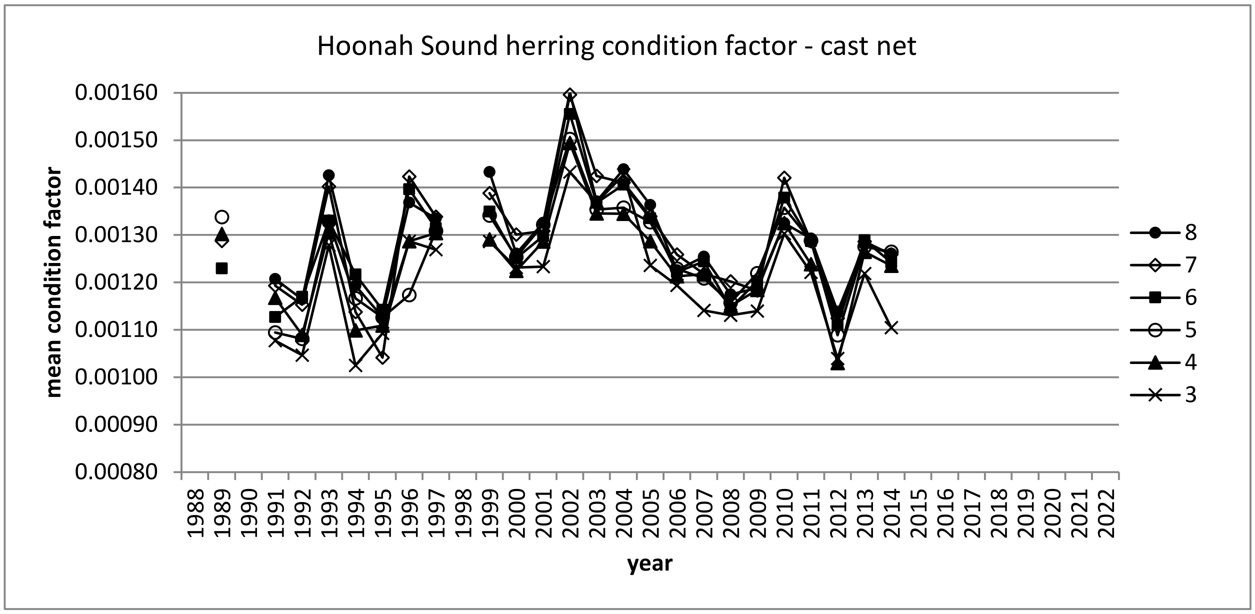

Figure 64.–Mean condition factors of age-3 through age-8 herring for the Hoonah Sound spawning population, based on spring cast net samples taken during active spawning.

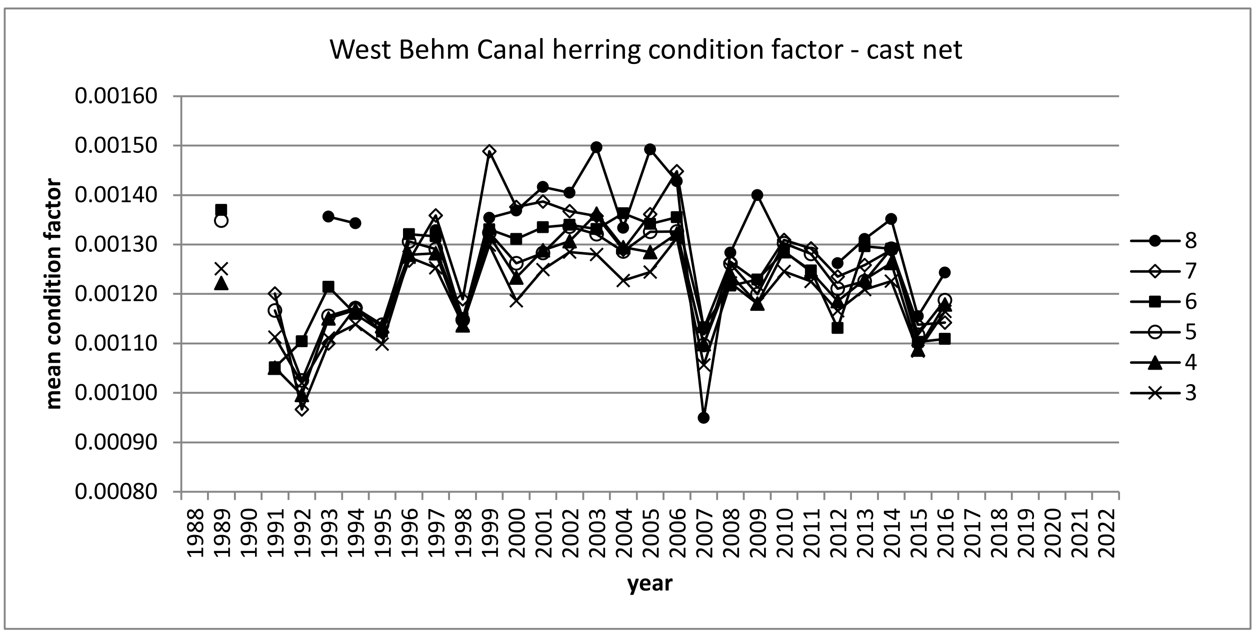

Figure 65.–Mean condition factors of age-3 through age-8 herring for the West Behm Canal spawning population, based on spring cast net samples taken during active spawning. 2015 condition factors are probably biased low due to required additional sample handling that resulted in loss of weight.

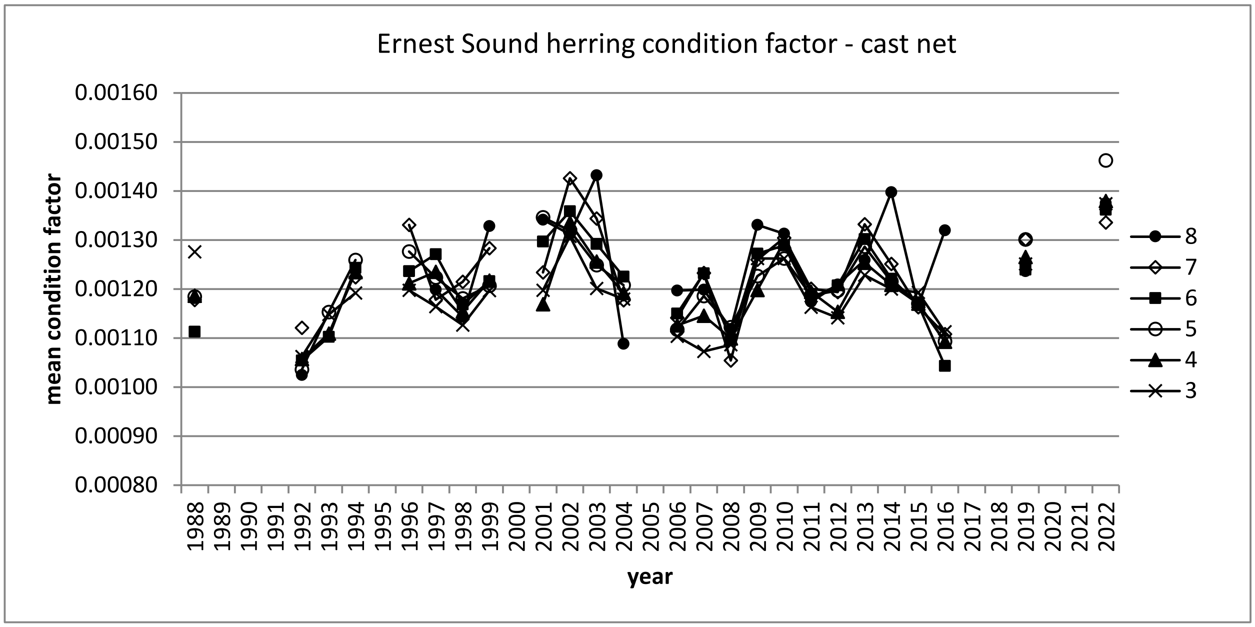

Figure 66.–Mean condition factors of age-3 through age-8 herring for the Ernest Sound spawning population, based on spring cast net samples taken during active spawning.

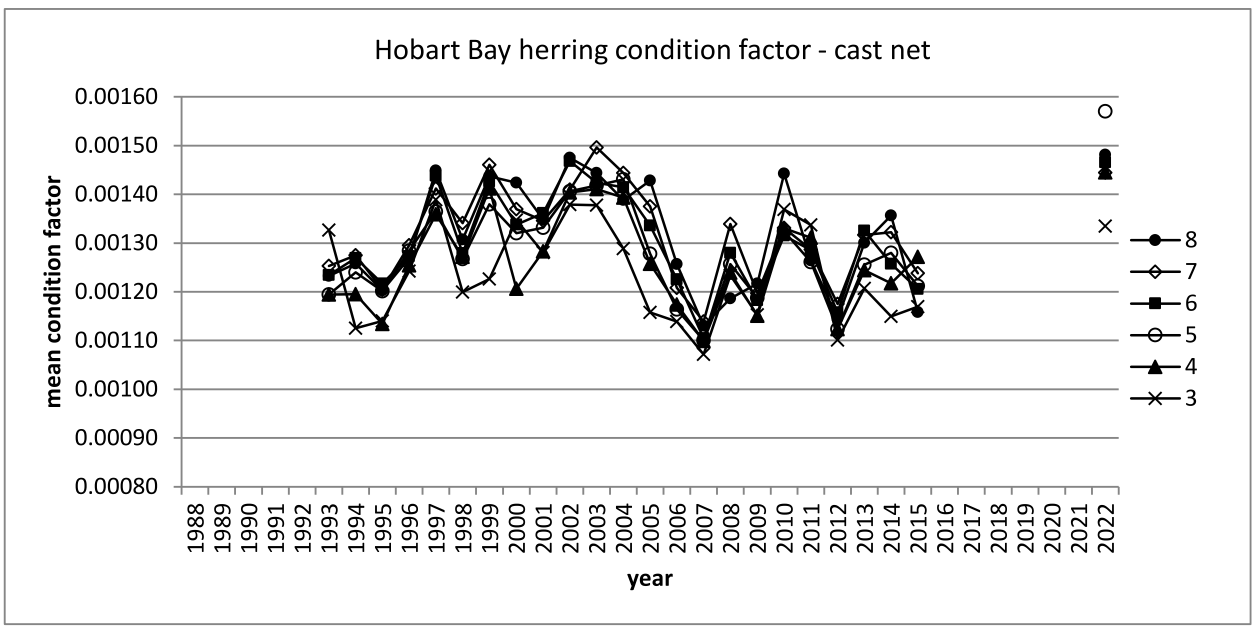

Figure 67.–Mean condition factors of age-3 through age-8 herring for the Hobart Bay spawning population, based on spring cast net samples taken during active spawning.

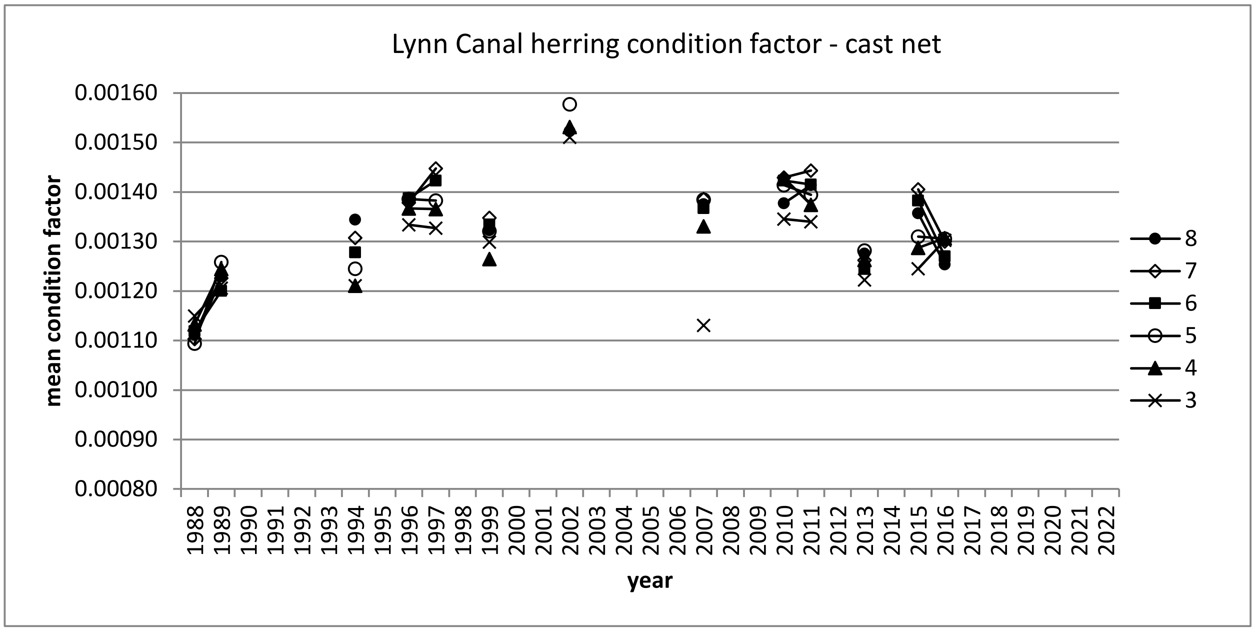

Figure 68.–Mean condition factors of age-3 through age-8 herring for the Lynn Canal spawning population, based on spring cast net samples taken during active spawning.

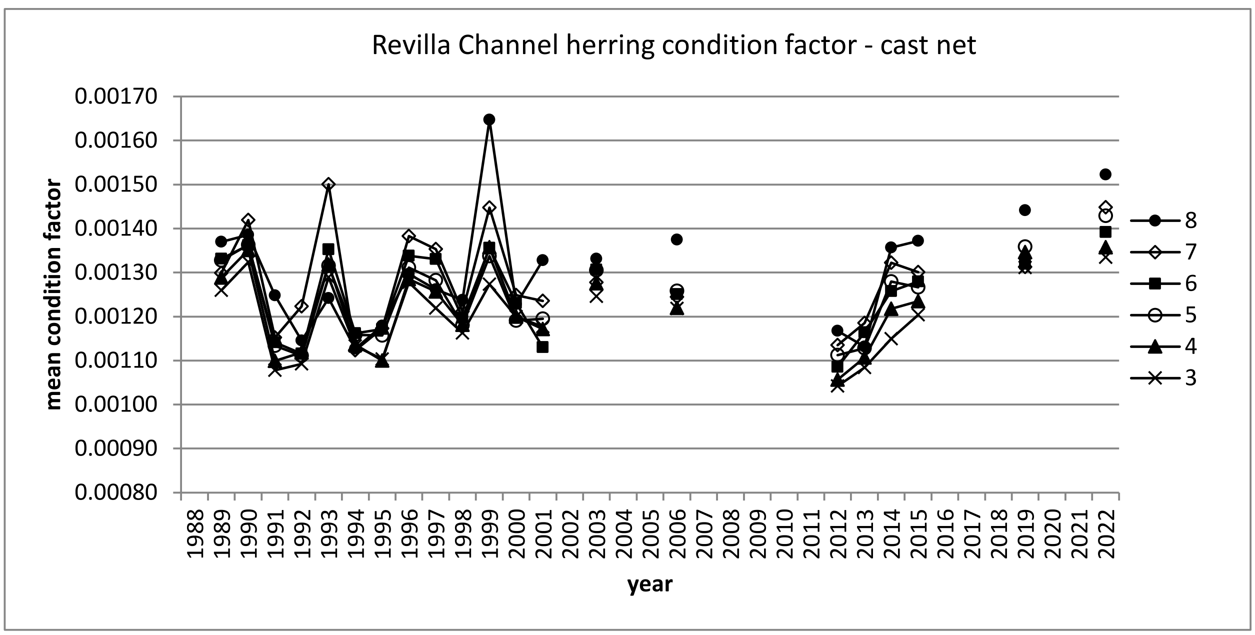

Figure 696.–Mean condition factors of age-3 through age-8 herring for the Revilla Channel spawning population, based on spring cast net samples taken during active spawning.

APPENDIX A: KEY TO VEGETATIVE SUBSTRATE TYPES USED FOR HERRING SPAWN DEPOSITION SURVEY

Appendix A1.–Key to vegetative substrate types used for herring spawn deposition survey.

Code	Expanded code	Species included	Latin names
AGM	Agarum	Sieve kelp	*Agarum clathratum*
ALA	Alaria	Ribbon kelps	*Alaria marginata*, *A. nana*, *A. fistulosa*
ELG	Eel grass	Eel grass, surfgrasses	*Zostera marina*, *Phyllospadix serrulatus*, *P. scouleri*
FIL	Filamentous algae	Sea hair	*Enteromorpha intestinalis*
FIR	Fir kelp	Black pine, Oregon pine (red algae)	*Neorhodomela larix*, *N. oregona*
FUC	Fucus	Rockweed	*Fucus gardneri*
HIR	Hair kelp	Witch's hair, stringy acid kelp	*Desmarestia aculeata*, *D. viridis*
LAM	Laminaria	split kelp, sugar kelp, suction-cup kelp	*Laminaria bongardiana*, *L. yezoensis* (when isolated and identifiable), *Saccharina latissima* (formerly *L. saccharina)*
LBK	Large leafy brown kelps	Five-ribbed kelp, three-ribbed kelp, split kelp, sugar kelp, sea spatula, sieve kelp, ribbon kelp	*Costaria costata*, *Cymathere triplicata*, *Laminaria* spp., *Pleurophycus gardneri*, *Agarum*, *Alaria* spp.
MAC	Macrocystis	Small perennial kelp	*Macrocystis* spp.
NER	Nereocystis	Bull kelp	*Nereocystis leutkeana*
RED	Red algae	All red leafy algae (red ribbons, red blades, red sea cabbage, Turkish washcloth)	*Palmaria mollis*, *P. hecatensis*, *P. callophylloides*, *Dilsea californica*, *Neodilsea borealis*, *Mastocarpus papillatus*, *Turnerella mertensiana*
ULV	Ulva	Sea lettuce	*Ulva fenestrata*, *Ulvaria obscura*
COR	Coralline algae	Coral seaweeds (red algae)	*Bossiella*, *Corallina*, *Serraticardia*

APPENDIX B: KEY TO BOTTOM TYPES USED FOR HERRING SPAWN DEPOSITION SURVEY

Appendix B1.–Key to bottom types used for herring spawn deposition survey.

Code	Expanded code	Definition
RCK	Bedrock	Various rocky substrates >1 m in diameter
BLD	Boulder	Substrate between 25 cm and 1 m
CBL	Cobble	Substrate between 6 cm and 25 cm
GVL	Gravel	Substrate between 0.4 cm and 6 cm
SND	Sand	Clearly separate grains of <0.4 cm
MUD	Mud	Soft, paste-like material
SIL	Silt	Fine organic dusting (very rarely used)
BAR	Barnacle	Area primarily covered with barnacles
SHL	Shell	Area primarily covered with whole or crushed shells
MUS	Mussels	Area primarily covered with mussels
WDY	Woody debris	Any submerged bark, logs, branches or root systems

APPENDIX C: SPAWN SURVEYS BY DATE

Appendix C1.–Aerial and skiff herring spawn surveys by date, in Craig, West Behm Canal, Revilla Channel, and other areas (Ketchikan Management Area), Southeast Alaska in 2022.

Craig

Date	Activity
March 19, 2022	Limited predator activity.
March 26, 2022	Increased predator activity.
March 31, 2022	Significant predator activity around Fish Egg and Abbess Islands and Klawock Reef.
April 4, 2022	Significant predator activity around Fish Egg, Clam, and Wadleigh Islands.
April 7, 2022	0.1 nmi of spawn on East San Fernando Island.
April 8, 2021	4.1 nmi of spawn on East San Fernando, Fish Egg, and Ballandra Islands, and Port Bagial.
April 9, 2022	13.2 nmi of spawn on East San Fernando, Port Bagial, Fish Egg and Ballandra Island.
April 10, 2022	26.4 nmi of spawn from Rosary Islands to the Coronados Islands.
April 11, 2022	No flight
April 12, 2022	No flight
April 13, 2022	1.6 nmi of spawn on the Prince of Wales shoreline between Blanquizal and Ildefonso.
April 14, 2022	0.2 nmi of spawn near the Palisades
April 15, 2022	0.2 nmi of spawn near the Palisades
April 16, 2022	0.1 nmi of spawn near the Palisades
April 17, 2022	No survey

West Behm Canal

Date	Activity
April 7, 2022	Moderate predator activity.
April 8, 2022	0.4 nmi of spawn at Indian Point.
April 9, 2022	0.2 nmi of spawn near Indian Point.
April 10, 2022	no spawn observed; minimal predator activity
April 13, 2022	no spawn observed; minimal predator activity
April 14, 2022	no spawn observed; minimal predator activity
April 15, 2022	no spawn observed; minimal predator activity
April 16, 2022	no spawn observed; minimal predator activity
April 28, 2022	1.0 nmi of spawn near Pt. Francis

Revilla Channel (State waters)

Date	Activity
March 22, 2022	Moderate predator activity.
March 26, 2022	1.8 nmi of spawn on Dog and Double Islands.
March 27, 2022	5.8 nmi of spawn on Cat, Dog, Double, and Village Islands.
March 28, 2022	4.0 nmi of spawn on Cat, Dog, Double, and Village Islands.
March 29, 2022	1.3 nmi of spawn on Dog and Village Islands.
March 30, 2022	No spawn. Limited predator activity.
March 31, 2022	No activity.
April 4, 2022	No activity.
April 9, 2022	Spawn dive depositon survey begins.

Revilla Channel (Annette Island Reserve waters)

Date	Activity
March 29, 2022	0.3 nmi of spawn at Crab Bay.

Kasaan Bay

Date	Activity
April 15, 2022	3.1 miles of spawn around Sandy Point.
April 16, 2022	5.1 nmi of spawn around Sandy Point and near Kasaan village.

Sea Otter Sound

Date	Activity
April 13, 2022	1.3 nmi of spawn south of Gas Rock.
April 15, 2022	5.0 nmi of spawn from Camp Island south towards Karheen Pass
April 17, 2022	2.5 nmi of spawn from Gas Rock to Port Alice.

Mountain Point

Date	Activity
April 16, 2022	0.8 nmi of spawn near Bugges Beach and Dairy
April 18, 2022	0.2 nmi of spawn near Bugges Beach

Appendix C2.–Aerial and skiff herring spawn surveys by date, in Sitka Sound and Hoonah Sound (Sitka Management Area), Southeast Alaska in 2022.

March 08: Dupuis. 0830–0900. Today's aerial survey covered Sitka Sound from Eastern Channel to St. Lazaria in the south, to Eastern Bay in the north. Weather was clear and calm with sunny skies and excellent visibility. No herring schools or spawn was seen. Herring predators were observed throughout the area. Most whales and sea lions were seen west of Gagarin Island. The largest concentration of humpback whales (~20) was seen in the deeper waters west of Bieli Rocks and a raft of approximately 100 sea lions were off Inner Point.

March 12: Jones. 0800–0920. Yesterday's planned aerial survey was canceled due to poor visibility from snow. Today's aerial survey covered from Biali Rock and Windy Passage to Hayward Strait, including Biorka Island, St. Lazaria, Vitskari Rocks, Eastern Channel, Middle Island, and Starrigavan. Weather was fair, with light winds, and variable visibility having occasional mixed rain and snow. No herring schools or herring spawn was observed. Herring predators were scattered throughout Sitka Sound. Humpback whales were mostly concentrated around Vitskari Rocks, while sea lions were seen hauled out near Biorka Island (~100 sea lions) and Biali Rock (~85 sea lions). Additionally, a raft of at least 50 sea lions was seen by Gagarin Island.

March 14: Dupuis. 0830–0900. Today's aerial survey covered Sitka Sound from Eastern Channel and Vitskari Rocks to Hayward Strait and Eastern Bay. Weather and visibility was poor with 15kt winds, fog, and rain. No herring schools or spawn was observed, although herring predators were seen throughout Sitka Sound. The highest concentration of humpback whales were seen near Vitskari Rocks, while smaller numbers of sea lions were observed east of Middle Island and in Hayward Strait.

March 15: Jones. 0900–1000.Today's aerial herring survey covered Sitka Sound from Eastern Channel and Vitskari Rocks to Krestof Sound and the southern entrance of Olga Strait. Survey conditions were good with light winds, overcast skies, and good visibility. No herring schools or spawn were observed today. Herring predators were seen widely scattered across Sitka Sound. Most humpback whales were concentrated in the deeper waters between Vitskari Rocks and Chaichei Islands. The largest group of sea lions was observed off Inner Point.

One successful test set was conducted today; the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
11:20	Vitskari Rocks	50	0	7.8	118	39

March 16: Dupuis. 0815–0845. Today's aerial herring survey covered Sitka Sound from Makhnati Island to Krestof Sound. Survey conditions were poor with 20-knot winds, overcast skies, and rain. No herring schools or spawn were observed today. Herring predator numbers and distributions in the surveyed area were consistent with previous surveys. Most humpback whales were concentrated in the deeper waters west of Bieli Rocks. Several smaller groups of sealions were observed near Bieli Rocks and Inner Point.

March 17: Jones. 0900–0945. Today's aerial herring survey covered Sitka Sound from Eastern Channel, and along the eastern Kruzof shoreline to Eastern Bay. Survey conditions were poor with 15-20 knot winds, overcast skies with a low cieling, and rain. Difficult viewing conditions affected the survey with air turbulence, many white caps, and passing squalls limiting visibility. No herring schools or spawn were observed today. For the herring predators that were seen, humpback whales were south of Eastern Bay and in the core area among the western Kasiana Islands; with groups of sea lions off Guide Island, Bieli,Rocks, and Crow Island.

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March 18: Dupuis. Flight cancelled due to high winds.

March 19: Dupuis. 0800–0930. Today's aerial survey covered Sitka Sound from Crawfish Inlet to Salisbury Sound. Survey conditions were good with 10-knot winds and overcast skies. No herring schools or spawn were observed. Concentrations of humpback whales were observed north of Vitskari Rocks, north of Middle Island and east of the Siginaka Islands. Groups of sealions were scattered throughout the survey area with the largest concentrations located off of Biorka Island and near Inner Point.

March 20: Dupuis. 0800–0900. The aerial survey conducted today covered Sitka Sound from Crawfish Inlet to Salisbury Sound. Weather during the flights was good with overcast skies, 10–15-knot winds, and good visibility. No herring or herring spawn were observed on either flight. Between March 19 and 20, concentrations of herring predators shifted from Vitskari Rocks, Bieli Rock, and east of the Siginaka Islands to Hayward Strait. Today's flight showed numerous groups of whales between Inner Point and Guide Island; larger groups of sealions were seen near Kamenoi Point and Kresta Point.

March 21: Dupuis. 0800–0900. The aerial survey conducted on March 21 covered Sitka Sound along the eastern Kruzof Island shoreline to Eastern Bay and north to Salisbury Sound. Survey conditions were poor with 20-knot winds, overcast skies with a low ceiling, rain, and snow. Difficult viewing conditions affected the survey with air turbulence, many white caps, and passing squalls limiting visibility. No herring schools or spawn were observed. For the herring predators that were seen, humpback whales were concentrated in Hayward Strait; groups of sea lions were observed off Inner Point and Mountain Point.

Early in the morning of March 21, a grounded vessel in Neva Strait spilled an unknown quantity of diesel fuel. A known source of the release was the vessel's 13,000-gallon capacity forward port tank, which has since been almost fully pumped out by Hanson Maritime. A cleanup response is currently underway which has included continued free product recovery, sealing of the vessel's manifolds, and plugging the fuel vents. From aerial surveys conducted in the area on March 21, it appeared that sheening was limited to the southern end of Neva Strait and extending to the north as far as Kane Island in Salisbury Sound. The department is currently working with DEC to track the geographic extent of the spilled fuel and to assess potential impacts to the subsistence and commercial herring fisheries in Sitka Sound. Because the State of Alaska has a zero-tolerance policy with respect to fuel contamination of seafood, the department will not open a commercial fishery or conduct test fishing in areas where there is a risk of fuel contamination of gear, vessels, or harvested fish.

March 22: Dupuis. Today's aerial survey was brief and covered Sitka Sound from Makhnati Island to Krestof Sound. Weather during the flight was very poor with 45-knot winds, low overcast skies, and rain. Difficult viewing conditions affected the survey with air turbulence, many white caps, and low visibility due to rain. No herring schools or spawn were observed. For herring predators that were seen, humpback whales were concentrated in Hayward Strait between Guide Island and Kamenoi Point.

The *R/V Kestrel* arrived in Sitka Sound at 8:30 a.m. and began surveying for herring schools. Although high winds and rough seas limited the area the *R/V Kestrel* could survey, numerous large schools of herring were observed in Hayward Strait.

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. The sheen remains in Neva Strait heading north to Salisbury Sound.

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March 23: Jones. 0800–0930. Today's aerial survey covered from Salisbury Sound to West Crawfish Inlet. Weather during the flight was fair with 15-knot winds, low overcast skies, and occasional rain. Viewing conditions were fair with occasional low clouds affecting visibility. No herring spawn was observed. Most herring predators were concentrated between Crow Island and Hayward Strait. Numerous whales were seen between Guide Island and Kamenoi Point in Hayward Strait, while sea lions were scattered throughout Sitka Sound.

The *R/V Kestrel* surveyed Sitka Sound for herring schools throughout the day. A very large biomass of herring was seen in the deeper waters northwest of Bieli Rocks. Numerous large herring schools were also observed in Hayward Strait, north of Middle Island, and southwest of the Siginaka Islands.

Two successful test sets were conducted today, the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
9:53	Hayward Str	30	5.6	2	103	30
13:00	Hayward Str	90	9.2	1.6	120	42

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. This includes tracking the geographic extent of the spilled fuel and assessing any potential impacts to the subsistence and commercial herring fisheries in Sitka Sound. Today's aerial survey showed the diesel sheen extended from Whitestone Narrows through Neva Strait. Dispersed traces of the spill were also seen in St. John Baptist Bay and parallel to the southern shoreline of Salisbury Sound as far north as Sinitsin Cove. Sheening was not apparent in Nakwasina Sound, Krestof Sound, or Olga Strait.

March 24: Jones. 0810–0900. Today's aerial survey covered from Salisbury Sound to Shoals Point in Sitka Sound. Weather during the flight was fair with 15-knot E winds, overcast skies, and good viewing conditions. No herring spawn was observed. Herring predators were concentrated on the Kruzof Island shoreline from Shoals Point to Hayward Strait and in Promisla and Eastern Bays. Industry pilots observed visible schools of herring from the air on the western shore of Shoals Point.

The *R/V Kestrel* surveyed Sitka Sound for herring schools throughout the day. Numerous large schools were observed in shallower waters from Fred's Creek up into Hayward Strait and extending into Promisla and Eastern Bays. Additionally numerous schools were observed along the Sitka road system from Watson Point to the northern end of Middle Island.

Five successful test sets were conducted today, the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
9:45	Mountain Pt	30	11.2	1.5	134	53.6
10:30	Kamenoi Pt	50	10.1	0.6	117	48.1
12:30	Hayward Str	15	9.8	1.5	127	51
14:20	Promisla Bay	75	9.7	1.7	121	44
14:30	Eastern Bay	100	11	0.8	131	48

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The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. Today's aerial survey showed the diesel sheen extended from Salisbury Sound through Neva Strait and lighter sheening was observed in Krestof Sound and Olga Strait. Sheening was not apparent in Nakwasina Sound, Hayward Strait, and the waters east of the Siginaka Islands. Multiple flights conducted throughout the day showed that visible sheen did not continue to spread south through the Magoun Islands and Olga Strait.

March 25: Jones. 0845–1000. Today's aerial survey covered from Salisbury Sound to Eastern Channel and Shoals Point in Sitka Sound. Weather during the flight was fair with 15-knot winds from the south and overcast skies with mixed snow and rain. Viewing conditions were difficult at times due to a low ceiling and precipitation. No herring spawn was observed. Herring predators were scattered throughout Sitka Sound with whales mostly concentrated along the Kruzof Island shoreline from Shoals Point to Hayward Strait. A large concentration of sealions were observed off Inner Point.

Department and industry vessels surveying Sitka Sound located very large schools of herring in the shallower waters of southern Kruzof and Krestof Islands from Shoal's Point to Eastern Bay. Numerous schools were also located between Watson Point and Middle Island and near Crow Island. Later in the day an industry vessel observed multiple large schools of herring moving south around Makhnati Island.

Five successful test sets were conducted on March 25 and the results follow:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
8:56	S Siganakas	60	7.7	2.8	115	46.9
11:02	Promisla Bay	75	9.8	1.7	119	52
11:31	Brents Beach	50	9.8	1.1	122	57
11:45	Mountain Pt	150	10.9	1.1	132	49
15:30	Mountain Pt	50	9.3	1.5	121	49

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. Today's aerial survey showed the diesel sheen extended from Neva Strait to Salisbury Sound. No apparent sheen was observed south of Whitestone Point in Neva Strait. Multiple aerial surveys conducted throughout the day showed that Krestof Sound, Olga Strait, Nakwasina Sound, Siginaka Islands, and Hayward Strait appeared clear of any sheen today.

March 26: Jones. 0845–1000. Today's aerial survey covered from Crawfish Inlet to Salisbury Sound. Weather during the flight was fair with 5-knot winds and clear skies. Visibility was hindered at times with occasional fog, sun glare, or shadows but overall was good viewing conditions were good. No herring spawn was observed. A noticeable shift of herring predators was seen as they have moved further south than what has been seen in recent days. Whales and sealions were mostly concentrated along the southern shoreline of Kruzof Island and south to Goddard and Dorothy Narrows.

Department and industry vessels surveying Sitka Sound located very large schools of herring in the shallower waters of southern Kruzof Island from Shoal's Point to Kamenoi Point. An industry vessel observed numerous schools south of Sitka in the deeper waters of Eastern Channel and from Aleutkina Bay to Cape Burunof.

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Two successful test sets were conducted today; the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
8:30	Mountain Pt	40	7.3	2.7	101	49
8:52	Inner Pt	150	11.3	1.1	126	54

An opening of the Sitka Sound herring sac roe fishery occurred today from 11:00 a.m. until 12:15 p.m. Open waters for this fishery included the area south of 57°06.91′ N lat, north of 57°00.84′ N lat, and west of 135°31.25′ W long. The fishery was closed earlier than anticipated after it became apparent that overall herring quality was lower than industry requirements resulting in multiple sets being released. Harvest estimates from today's fishery will be included on the next fishery update. Harvest from the fishery that occurred on March 26, 2022, was approximately 450-tons of herring.

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. Today's aerial survey found spotty, light diesel sheen extending from Olga Strait, Neva Strait and Salisbury Sound.

<u>March 27:</u> Jones. 0815–0945. Today's aerial survey covered from Windy Passage to Salisbury Sound. Weather during the flight was good with 5-knot winds and partly cloudy skies. Visibility was hindered at times with sun glare but overall viewing conditions were good. Several herring schools were seen in areas of southern Krestof Sound, Hayward Strait, Kruzof Island shoreline, and Crescent Bay (Sitka Harbor). Approximately <u>1.6 nautical miles of herring spawn</u> was observed, including the areas of Mountain Point, Inner Point, and Crow Pass. Herring predators were mostly concentrated along the Kruzof shoreline from Vitskari Rocks to Mud Bay.

Department and industry vessels surveying Sitka Sound located very large schools of herring in the shallower waters of southern Kruzof and Krestof Islands from Shoal's Point to Eastern Bay and in Hayward Strait.

Department and industry vessels surveying Sitka Sound on March 28 located very large schools of herring in the shallower waters of Hayward Strait and the Magoun Islands. South of Sitka several schools of herring were observed between Aleutkina Bay and Cape Burunof.

One successful test set was conducted today; the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
8:56	Hayward Str	100	11.5	3.37	125	51.2

An opening of the Sitka Sound herring sac roe fishery occurred on March 28, 2022 from 10:00 a.m. until 6:00 p.m., as stated in field announcement on VHF channel 10. Open waters for this fishery included the area south of 57°10.78′ N lat, north of 57°07.98′ N lat, and west of 135°30.76′ W long. Harvest estimates from this fishery will be included on the next fishery update. Harvest from the fishery that occurred on March 27, 2022 was approximately 2,700-tons of herring. Harvest from the fishery that occurred on March 28, 2022 was approximately 2,700-tons of herring. Total harvest in the fishery through March 28 is approximately 5,900-tons of herring.

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. Today's aerial survey found spotty, light diesel sheen extending from Olga Strait, Neva Strait, and Salisbury Sound.

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March 29: Jones. 0800–0915. The aerial survey conducted on March 29 covered Sitka Sound from Goddard and St. Lazaria in the south and north to Salisbury Sound. Weather during the flight ranged from fair to poor with 20-knot winds, overcast skies, and rain. Viewing conditions were difficult at times with turbulence with occasional rain and fog obstructing visibility. Active spawning has slowed along the Kruzof shoreline but expanded slightly to new areas in the regulatory closed waters near Crow Pass. Approximately 1.3 total nautical miles of herring spawn was observed today in areas including Hayward Strait, Middle Island, and around Crow Island. Herring predators were widely scattered across Sitka Sound; with most whales concentrated at Hayward Strait while most sealions were at Inner Point.

Department and industry vessels surveying Sitka Sound on March 29 located very large schools of herring in the shallower waters of Hayward Strait. Scattered small schools were observed along the southern shore of Kruzof Island from Kamenoi Point to Fred's Creek. Numerous smaller schools of herring were observed in Crow Pass, around Middle Island and near the Kasiana Islands.

One successful test set was conducted March 29 with the results:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
09:00	Hayward Strait	50	13.3 %	1.7 %	119	56.7

An opening of the Sitka Sound herring sac roe fishery occurred on March 29, 2022 from 10:30 a.m. until 1:30 p.m., as stated in field announcement on VHF channel 10. Open waters for this fishery included the area south of 57°10.78´ N lat, north of 57°07.98´ N lat, and west of 135°30.76´ W long. Harvest estimates from this fishery will be included on the next fishery update. Harvest from the fishery that occurred on March 29, 2022 was approximately 1,500-tons of herring, with cumulative harvest at approximately 7,300 tons of herring.

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. Today's aerial survey found spotty, light diesel sheen extending from Olga Strait, Neva Strait, and Salisbury Sound.

March 30: Jones. 0845-1000. The aerial survey conducted on March 30 covered Sitka Sound from Windy Passage to Salisbury Sound. Weather during the flight was poor with 20-knot winds, overcast skies, and rain. Viewing conditions were difficult with turbulence, low cloud ceiling, rain and fog often obstructing visibility. There was approximately 5.3 nmi of herring spawn observed today. Active spawning areas include Hayward Strait, eastern Kruzof shoreline, Middle Island, and near Crow Pass. Herring predators were difficult to see with the numerous white caps but appeared to be scattered across Sitka Sound. Most whales were concentrated at Hayward Strait while most sealions were at Inner Point.

Department and industry vessels surveying Sitka Sound on March 30 located very large schools of herring in the shallower waters of Hayward Strait, southern Krestof Sound and from St. Lazaria Island to Kamenoi Point. Numerous schools of herring were observed in Crow Pass, around Middle Island and near the Kasiana Islands.

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One successful test set was conducted today; the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
09:20	Rob Point	50	13.5	0.46	121	55.00

An opening of the Sitka Sound herring sac roe fishery occurred on March 30, 2022 from 11:00 a.m. until 5:00 p.m., as stated in field announcement on VHF channel 10. Open waters for this fishery included the area south of 57°10.78′ N lat, north of 57°07.98′ N lat, and west of 135°30.76′ W long. Additionally, the waters within 200-yards from shoreline at mean high tide between a point on the Kruzof Island shoreline at 57°09.19′ N lat, 135°34.76′W long and Point Brown at 57°09.02′ N lat, 135°34.06′W long were closed to commercial fishing because subsistence roe-on-branch sets were identified by the department in that area of herring spawn. Harvest from the fishery that occurred on March 30, 2022 was approximately 1,700-tons of herring, with total cumulative harvest at approximately 9,000-tons of herring.

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. Today's aerial survey found spotty, light diesel sheen extending from Olga Strait, Neva Strait, and Salisbury Sound. Because

March 31: Jones. 0845–1000. The aerial survey conducted on March 31 covered Sitka Sound from Windy Passage to Salisbury Sound. Weather during the flight was adequate with 5-knot winds, overcast skies, rain, and snow. Viewing conditions were mostly good with occasional snow, rain, or fog obstructing views. There was approximately 11.9 nmi of herring spawn observed today. Active spawning areas include Hayward Strait, eastern Kruzof shoreline, Middle Island, near Crow Pass, Eastern Bay, and Promisla Bay. The cumulative herring spawn mileage to date is 15.6 nmi. Herring predators were scattered across Sitka Sound. Most whales were concentrated at Hayward Strait and Hotsprings Bay, while most sealions were in the Magoun Islands.

Department and industry vessels surveying Sitka Sound on March 31 located very large schools of herring in the shallower waters of Hayward Strait and southern Krestof Sound. Scattered schools of herring were observed on the Kruzof Island shore from Fred's Creek to Kamenoi Point and in Eastern and Promisla Bays; most of the fish observed in these locations were in shallow water near the beaches. Numerous schools of herring were also observed in Crow Pass, around Middle Island and near the Kasiana Islands.

One successful test set was conducted today, the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
09:00	Rob Point	150	9.2	-	123	45.7

An opening of the Sitka Sound herring sac roe fishery occurred on March 31, 2022 from 10:30 a.m. until 4:30 p.m. Open waters for this fishery included the area south of 57°10.78′ N lat and north of 57°09.20′ N lat. Harvest from the fishery that occurred on March 31, 2022 was approximately 2,100-tons of herring with cumulative harvest approximately 11,100-tons of herring.

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. Today's aerial survey found spotty, light diesel sheen extending from Olga Strait, Neva Strait, and Salisbury Sound.

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April 1: Jones. 0800–1000. The aerial survey conducted on April 1 covered Sitka Sound from Crawfish Inlet to Salisbury Sound. Weather during the flight was adequate with 3-knot winds, overcast skies and rain. Viewing conditions were mostly fair with occasional rain or fog obstructing views. There was approximately 12.9 nautical miles (nmi) of herring spawn observed today. Active spawning areas include Hayward Strait, eastern Kruzof shoreline, Magoun Islands, Middle Island, Chaichei and Kasiana Islands, near Crow Pass, Eastern Bay, and Promisla Bay. The cumulative herring spawn mileage to date is 21.7 nmi. Herring predators were scattered across Sitka Sound. Most humpback whales were concentrated on the Kruzof Island shoreline and southern Krestof Sound, while most sealions were in Windy Passage. Multiple gray whales were observed near Freds Creek.

Department and industry vessels surveying Sitka Sound on April 1 located very large schools of herring in the shallower waters of southern Krestof Sound. Smaller, scattered schools of herring were observed on the Kruzof Island shore from Inner Point to Kamenoi Point and in Eastern and Promisla Bays; most of the fish observed in these locations were in shallow water near the beaches. Numerous schools of herring were also observed around Middle Island and near the Kasiana Islands.

One successful test set was conducted today; the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
09:00	S Krestof Sd	100	10.0	0.05	125	46.0

An opening of the Sitka Sound herring sac roe fishery occurred on April 1, 2022, from 10:30 a.m. until 4:30 p.m., as stated in field announcement on VHF channel 10. Initial open waters for this fishery included the area south of 57°10.78´ N lat and north of 57°09.20´ N lat. Additionally, the waters within the Magoun Islands north of a line from a point at 57°09.63´ N lat, 135°34.01´W long to a point at 57°09.63´ N lat, 135°34.24´W long were closed to commercial fishing because subsistence roe-on-branch sets were identified by the department in that area of herring spawn. At 2:15 p.m. the southern boundary of the fishery was modified by field announcement on VHF channel 10 to waters north of a line from the Kruzof Island shoreline at 57°09.20´ N lat, 135°34.75´W long and Rob Point at 57°09.37´ N lat, 135°33.31´W long. This adjustment was made to allow access to herring located in the southern end of Port Krestof. Harvest from the fishery that occurred on April 1, 2022, was approximately 1,400-tons of herring.

The department continues to work with the DEC in response to the grounding of the vessel in Neva Strait. Today's aerial survey found spotty, light diesel sheen extending from Olga Strait through Neva Strait.

April 2: Jones. 0800–0900. The aerial survey conducted on April 2 covered Sitka Sound from Shoals Point to Hayward Strait. Weather during the flight was adequate with 40-knot winds, overcast skies. Viewing conditions were difficult at times with heavy turbulence and white caps. There was approximately 15.1 nautical miles (nmi) of herring spawn observed today. Active spawning areas include Hayward Strait, Magoun Islands, Promisla Bay, Eastern Bay, Crow Island, Chaichei and Kasiana Islands. The cumulative herring spawn mileage to date is 31.1 nmi. Herring predators were difficult to spot today due to viewing conditions. Gray whales were seen along the Kruzof shoreline and humpback whales were in Hayward Strait. Department and industry vessels surveying Sitka Sound on April 2 located very large schools of herring in the shallower waters of southern Krestof Sound and northern Hayward Strait. Numerous schools of herring were also observed around along the Sitka road System from Watson Point to Old Sitka Rocks.

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One successful test set was conducted today; the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
09:30	S Krestof Sd	75	10.95	0	129	50

An opening of the Sitka Sound herring sac roe fishery occurred on April 2, 2022 from 11:00 a.m. until 5:30 p.m., as stated in field announcement on VHF channel 10. Open waters for this fishery included the area south of 57°10.78′ N lat and north of 57°08.95′ N lat. Additionally, the waters within the Magoun Islands north of a line from a point at 57°09.63′ N lat, 135°34.01′W long to a point at 57°09.63′ N lat, 135°34.24′W long and the waters within 200-yards from shoreline at mean high tide between a point on the Kruzof Island shoreline at 57°09.20′ N lat, 135°34.75′W long and Point Brown at 57°08.95′ N lat, 135°33.83′W long were closed to commercial fishing because subsistence roe-on-branch sets were identified by the department in that area of herring spawn. Harvest from the fishery that occurred on April 2, 2022 was approximately 1,700-tons of herring. Harvest in the fishery through April 3 is approximately 14,300-tons of herring.

<u>April 3:</u> Dupuis. 1630–1730. Poor weather prevented a thorough aerial survey from being conducted this morning, however by late afternoon a brief survey was able to be flown and covered Sitka Sound from Watson Point to Krestof Sound. Approximately <u>3.4 nautical miles of active herring spawn</u> was observed during the survey in the Magoun Islands, DeGroff Bay, and near Mud Bay. This morning herring spawn was observed along the Sitka road system near Magic Island by department vessels, but had dissipated by the time of the aerial survey. Department and industry vessels surveying Sitka Sound on April 3 located small schools of herring east of the Kasiana Islands. Industry vessels reported numerous schools of herring along the Sitka road System near Old Sitka Rocks. The *R/V Kestrel* departed Sitka Sound today at 11:00 a.m.

There were no test sets or opened fishery today. Harvest in the fishery through April 3 remains at approximately 14,300-tons of herring.

<u>April 4:</u> Dupuis. 0730–0900. The aerial survey conducted on April 4 covered Sitka Sound from Windy Passage to Krestof Sound. Weather during the flight was good with 5-knot winds and mostly cloudy skies. Viewing conditions were excellent. There was approximately <u>19.1 nautical miles (nmi) of herring spawn</u> observed on April 4. Active spawning areas include Krestof Sound, Magoun Islands, Promisla Bay, Eastern Bay, Siginaka Islands, Big and Little Gavanski Islands, Chaichei and Kasiana Islands, and along the Sitka road system from Starrigavan Bay to Watson Point. The cumulative herring spawn mileage to date is 45.5 nmi.

Two successful test sets were conducted today, the results are as follows:

Time	Area	Tons	% Mature roe	% Immature roe	Average weight	% Female
11:38	Redoubt Bay	75	14.7	0	135	58.6
12:09	Indian River	100	12.8	0	140	50.0

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An opening of the Sitka Sound herring sac roe fishery occurred on April 4, 2022, from 2:00 p.m. until 7:00 p.m., as stated in field announcement on VHF channel 10. Open waters for this fishery included the area south of 56°57.13′ N lat, north of 56°52.33′ N lat, and east of 135°28.24′W long. Additional open waters for this period included the area south of 57°02.88′ N lat, north of 57°01.57′ N lat, east of 135°20.20′W long, and west of 135°14.96′W long. The harvest estimate from the fishery that occurred on April 4 was approximately 2,150 tons of herring. Total harvest in the fishery through April 4 is approximately 16,400-tons of herring.

April 5: Dupuis. 0730–0915. The aerial survey conducted on April 5 covered Sitka Sound from Windy Passage to Salisbury Sound. Weather during the flight was good with 20-knot winds and cloudy skies. Viewing conditions were good. There was approximately 6.7 nautical miles (nmi) of herring spawn observed on April 5. Active spawning areas include Magoun Islands, Eastern Bay, Siginaka Islands, Apple and Kasiana Islands, Whiting Harbor, and along the Sitka road system from Halibut Point to Watson Point. The cumulative herring spawn mileage to date is 48.6 nmi. No test sets were conducted today, but an opening of the Sitka Sound herring sac roe fishery occurred on from 11:00 a.m. until 7:00 p.m., as stated in field announcement on VHF channel 10. Open waters for this fishery included the area south of 57°00.80′ N lat, north of 56°52.33′ N lat, and east of 135°28.24′W long. The harvest estimate from the fishery that occurred on April 5 was approximately 2,980 tons of herring. Total harvest in the fishery through April 5 is approximately 19,400-tons of herring.

April 6: Dupuis. 0800-0900. The aerial survey conducted on April 6 covered Sitka Sound from Windy Passage to Salisbury Sound. Weather during the flight was good with 20-knot winds and cloudy skies. Viewing conditions were good. There was approximately 5.5 nautical miles (nmi) of herring spawn observed on April 6. Active spawning areas include Eastern Bay, Siginaka Islands, Apple and Kasiana Islands, Whiting Harbor, along the Sitka road system near Halibut Point and Watson Point, and near Crescent Harbor. The cumulative herring spawn mileage to date is 50.5 nmi.

The Sitka Sound herring sac roe fishery daily openings began at 8:00 a.m. on Wednesday, April 6, 2022 and will continue until closed by field or advisory announcement. Open area includes the waters of Deep Inlet and Aleutkina Bay south of 57°00.81′ N lat and east of 135°21.93′ W long and the waters south of the latitude of Povorotni Point at 56°57.13′ N lat and north of the latitude of Aspid Cape at 56°41.75′ N lat, except for the waters of Whale and Necker Bays. Fishing boundaries and times may be modified by subsequent announcement. The harvest estimate from the fishery that occurred on April 6 was approximately 1,000-tons of herring. Total harvest in the fishery through April 6 is approximately 20,400-tons of herring.

April 7: Dupuis. 1345–1445. The aerial survey conducted on April 7 covered Sitka Sound from West Crawfish Inlet to Krestof Sound. Weather during the flight was marginal with 30-knot winds, cloudy skies, and rain showers; however, viewing conditions were good for observing herring and herring spawn. There was approximately 3.5 nmi of herring spawn was observed on April 7. Active spawning areas include Whiting Harbor, along the Sitka road system near Halibut Point, Harbor Point and Watson Point, near Crescent Harbor and Sealing Cove Harbor, Redoubt Bay, and Hot Springs Bay. The cumulative herring spawn mileage to date is 52.3 nmi.

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Daily openings of the Sitka Sound herring sac roe fishery, that started April 6th, will continue until it is closed. The harvest estimate from the fishery that occurred on April 7 was approximately 2,000-tons of herring. Total harvest in the fishery through April 7 is approximately 22,400-tons of herring.

April 8: Dupuis. 0830–0915. The aerial survey conducted on April 8 covered Sitka Sound from Windy Passage to Big Gavanski Island. No aerial tracks were recorded on map. Weather during the flight was poor with 10-knot winds, cloudy skies with a low ceiling, and numerous snow showers; however, viewing conditions were fair for observing herring and herring spawn. There was approximately 5.6 nautical miles (nmi) of herring spawn observed on April 8. Active spawning areas include Whiting Harbor, near Crescent Harbor and Sealing Cove Harbor, Redoubt Bay, and Hot Springs Bay. The cumulative herring spawn mileage to date is 56.5 nmi. Jones. 0815-1400. A vessel survey was also conducted on April 8 to fill in spawn lines in the Hayward Strait to south Krestof Sound area. A total of 5.0 nmi of spawn was added from this survey to the cumulative mileage.

Daily openings of the Sitka Sound herring sac roe fishery, that started April 6th, will continue until it is closed. The harvest estimate from the fishery that occurred on April 8 was approximately 1,970-tons of herring. Total harvest in the fishery through April 8 is approximately 24,330-tons of herring.

April 9: Dupuis. 0815–0930. The aerial survey conducted on April 9 covered Sitka Sound from Windy Passage to Salisbury Sound. Weather during the flight was good with 5-knot winds, and partly sunny skies. Viewing conditions were good for observing herring and herring spawn. There was approximately 8.6 nmi of herring spawn was observed on April 9. Active spawning areas include Indian River, Povorotni Point, Redoubt Bay, and Hot Springs Bay.

Skiff surveys conducted on April 8 and April 9 recorded an additional 10.2 nmi of herring spawn that was not observed during the previous aerial surveys. The cumulative herring spawn mileage to date, including mileage recorded from the skiff surveys, is 71.2 nmi. Daily openings of the Sitka Sound herring sac roe fishery, that started April 6, will continue until it is closed. The harvest estimate from the fishery that occurred on April 9 was approximately 1,550-tons of herring. Total harvest in the fishery through April 9 is approximately 25,900-tons of herring.

April 10: Dupuis. 0815–0930. The aerial survey conducted on April 10 covered Sitka Sound from Windy Passage to Krestof Sound. Weather during the flight was good with 5-knot winds, and clear skies. Viewing conditions were good for observing herring and herring spawn. There was approximately 6.2 nautical miles (nmi) of active herring spawn observed on April 10. Active spawning areas include Siginaka Islands, Long Island, Povorotni Point, Redoubt Bay, Hot Springs Bay, Big Bay, Presidents Bay, and between First and Second Narrows. The cumulative herring spawn mileage to date is 72.9 nmi. The Sitka Sound herring sac roe fishery closed at 6:00 p.m. on Sunday, April 10, 2022. Openings have occurred daily from April 6 through April 10. The harvest estimate from the fishery that occurred on April 10 was approximately 470-tons of herring. Total harvest in the fishery through April 10 is approximately 26,350-tons of herring.

April 11: No aerial survey was conducted today due to high NE winds, however, we marked a few new spawn areas from satellite imagery (Sentinel Playground) since skies were clear. Approximately 0.8 nmi of active herring spawn was observed near Jackknife Islands and between First and Second Narrows.

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April 12: Jones. 0800–0845. The aerial survey conducted on April 12 covered Sitka Sound from Windy Passage to Western Channel. Weather during the flight was good with 20-knot winds, and clear skies. Viewing conditions were excellent for observing herring and herring spawn, however high turbulence reduced the geographic extent of the survey. There was approximately 1.8 nautical miles nmi of herring spawn observed on April 12. Active spawning areas included Taigud Island, Hot Springs Bay, Big Bay, Presidents Bay, and between First and Second Narrows

April 13: Jones. 0800–0915. The aerial survey conducted on April 13 covered Sitka Sound from Walker Channel to Salisbury Sound. Weather during the flight was good with 10-knot winds and clear skies. Viewing conditions were excellent, although NE winds did create some turbulence in areas. 5.7 nmi of active spawn was observed south of Sitka in Big Bay, President Bay, Lodge Island, and by the Jacknife Islands. Few humpback whales and sea lions were seen in the area, while mostly grey whales (50+) were observed along the Kruzof shoreline from Fred's Creek to Kamenoi Point.

April 14: Jones. 0700–0745. Today's aerial survey was from Eastern Channel through Windy Passage to Aspid Cape. Weather was good with 10-knot winds, clear skies, and excellent visibility. 7.9 nmi of active spawn was observed from the aerial survey. A vessel survey on April 14 (Jones/Coltharp) added an additional 1.0 nmi of active spawn while collecting cast net samples. Active spawn areas included: Elovoi, Golf, and Jackknife Islands; Hot Springs Bay, Big Bay, Windy Passage, and Lodge Island. The cumulative spawn mileage through April 14 is 84.7 nmi.

April 15: Jones. 0700–0800. Today's aerial survey extended from Eastern Channel to Walker Channel. Weather and visibility were excellent with clear sunny skies and light winds.11.9 nmi of active spawn was spotted today. Active spawn was located by Goddard, Dorothy Narrows, throughout Big Bay, Elovoi Island, Jackknife Islands, Golf Island, Gornoi Island, and Lodge Island. Cumulative spawn to date is 90.3 nmi.

April 16: Jones. 0700–0745. Today's aerial survey covered the area from Eastern Channel to Aspid Cape. Weather and visibility during the survey were excellent, with partly cloudy skies and light winds. A few small areas of active spot spawn were observed at Hot Springs Bay, Herring Bay, and by First Narrows, totaling 0.5 nmi of active spawn on April 16. Pilot Billy Vollendorf (Supercub) departed Sitka shortly after the survey.

A vessel survey (Jones/Coltharp, 0815–1200) was also conducted today south of Sitka from Povorotni, through Dorothy Narrows to Elovoi Island which added 1.3 nmi of spawn lines. Additional spawned areas seen on April 16 from the vessel included near Povorotni Pt, Herring Bay, and Hot Springs Bay.

Cumulative spawn to date is 90.4 nmi.

April 17: Dupuis. 1515–1600. Today's aerial survey with pilot Kevin Mulligan (Cessna 185) covered the area from Aspid Cape to Kamenoi Point. Weather and visibility were excellent with partly cloudy sky and light winds. No spawn was observed, although nearly 70 grey whales were seen from Low Island to Kamenoi Point.

April 18: Dupuis. 0845–1000. Today's aerial survey was with Kevin Mulligan (Cessna 185) and covered the area from Crawfish Inlet to Hoonah Sound. Weather and visibility were excellent with partly cloudy skies and light winds.

No spawn was observed in Sitka Sound or Hoonah Sound.

No herring predators were observed in Hoonah Sound.

This is likely the last aerial survey of the 2022 season.

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April 21: Dupuis. 1350–1530. Today's aerial survey was with Kevin Mulligan on a Cessna 185, covering Sitka Sound from the Kruzof shoreline to the Magoun Islands, Shelikof Bay, Salisbury Sound, and Hoonah Sound. Weather conditions were good with calm winds and sunny skies; however, bright sun and glare made for poor viewing conditions of herring spawn.

Areas of potential spawn were seen along Kruzof shoreline, Salisbury Sound, and Shelikof Bay; however, after consultation with other area management staff it was determined that these areas did not receive herring spawn. Questionable areas may have been attributed to wave or tidal fluctuations disturbing sediment, or herring larvae hatching from eggs.

No herring or herring spawn was observed in Hoonah Sound.

April 22: Dupuis. 0700–0800. Today's aerial survey was with Alaska Seaplanes on a Cessna 206, covering from the Kruzof shoreline, Sukoi Inlet, and Salisbury Sound. Weather conditions were good with calm winds and clear skies. Conditions were good for observing herring spawn. No herring or herring spawn was observed.

April 25: Dupuis. 0930–1100. Today's aerial survey was with Kevin Mulligan on a Cessna 185, covering Salisbury Sound, Hoonah Sound, and Peril Strait to Sitkoh Bay. Weather and viewing conditions were excellent with partly cloudy skies and light winds. Conditions were good for viewing herring and herring spawn. Approximately 0.3 nmi of spawn was observed on the western shoreline of Krestof Sound north of Mud Bay. No herring or herring spawn was observed in Hoonah Sound; however, 3 humback whales and several sea lions were observed on the southern shoreline of Hoonah Sound just east of Saook Bay.

A vessel survey (Dupuis/Jones) was also conducted today to ground-truth potential spawned areas in Salisbury Sound, as seen from the April 21 aerial survey. More active spawn had expanded in west Krestof Sound since the aerial survey. Although tides weren't ideal for a vessel survey, no herring spawn was observed in Salisbury Sound.

April 28: Dupuis. 1515–1650. Today's aerial survey was with Kevin Mulligan on a Cessna 185, covering Salisbury Sound, Hoonah Sound, and the length of Peril Strait to Tenakee Inlet. Weather was partly cloudy with 10kt winds and good visibility. A few humpbacks and sea lions were noted in Hoonah Sound and through Peril Strait. Areas of spot spawn were observed, including in Sitka Channel by the bridge, western shoreline of Krestof Sound, and at Point Hayes outside of Tenakee Inlet, accounting for 0.3 nmi of active spawn. There are no plans for further aerial surveys this season.

April 29: Ward Air pilot coincidentally flew by Peril Strait and saw spawn expanded to a larger area off of Catherine Island (Scott Forbes sent pics).

Appendix C3.–Aerial and skiff herring spawn surveys by date, at Bradfield Canal, Ernest Sound, Ship Island, Zimovia Strait and Eastern Passage, Bear Creek, Hobart Bay, and other areas within Petersburg-Wrangell Management Area in Southeast Alaska, 2022.

Bradfield Canal
Not surveyed in 2022.

Vixen Inlet/ Union Bay/Emerald Bay
Total miles of spawn: ~2.6 nmi
Spawning dates: sometime around 4/14
Peak spawning: unknown

4/14 ~1.2 nmi of active herring spawn and small schools, 30 sea lions, 700 scoters, 1,200 gulls
4/15 No herring spawn or schools observed, 9 sea lions, 2,100 scoters, 200 gulls
4/18 No herring spawn or schools observed, no sea lions, 500 scoters,3,000 gulls.
4/21 No herring spawn or schools observed, 1 sea lion, 4,000 scoters 1,200 gulls.
4/22 Skiff survey: an additional 1.4 nmi of eggs on the beach for a total of 2.6 nmi

Onslow/Stone/Brownson Island/Canoe Pass
Total miles of spawn: None
4/14 No herring spawn or schools observed, no predators or birds
4/15 No herring spawn or schools observed, 3 sea lions, no birds
4/18 No herring spawn or schools observed, no sea lions, no birds
4/21 No herring spawn or schools observed, 3 sea lions, no birds

Ship Island
Not surveyed in 2022

Zimovia St. and Eastern Passage
4/14 No herring spawn or schools observed, very few birds and sea lions
4/15 No herring spawn or schools observed, no sea lions, 500 scoters
4/18 No herring spawn or schools observed, no sea lions, few birds
4/21 No herring spawn or schools observed, no sea lions, 350 scoters

Bear Creek
Not surveyed in 2022.

Farragut Bay
Total miles of spawn: ~ 1.7 nmi
Spawning dates: 5/7-5/9
Peak spawning: 5/7 likely

4/22 No herring spawn or schools observed, 4 sea lions, 1 whale.
4/25 No herring spawn or schools observed, 27 sea lions, 2 whales, very few birds
4/27 No herring spawn or schools observed, 16 sea lions.
4/28 No herring spawn or schools observed, 12 sea lions, 3 whales, few birds.
4/30 No herring spawn or schools observed, 7 sea lions, 1 whale
5/4 No herring spawn or school of observed, 8 sea lions, few birds.

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5/7 ~1.3 miles of active Spawn numerous schools on beach, 1 whale, 20 sea lions.
5/9 ~0.4 miles of active spawn, 2 schools of herring, 3 sea lions, 1,050 scoters.
5/10 No herring spawn or schools observed, 1,000 scoters, few hundred gulls.
5/12 No herring spawn or schools observed, 600 scoters, few hundred gulls.

Hobart Bay
Total miles of spawn: 1.8 nm
Spawning dates: 5/12
Peak spawning: 5/12

4/22 No herring spawn or schools observed, 2 sea lions, 2 whales.
4/25 No herring spawn or schools observed, 4 sea lions.
4/27 No herring spawn or schools observed, 7 sea lions.
4/28 No herring spawn or schools observed, 3 whales, few birds.
4/30 No herring spawn or schools observed, 9 sea lions.
5/4 No herring spawn or schools observed, 3 sea lions, 7 whales.
5/7 No herring spawn observed, 27 sea lions, 8 whales, no birds.
5/9 No herring spawn or schools observed, 68 sea lions, 8 whales, 200 scoters.
5/10 No herring spawn observed, 3 sea lions.
5/12 ~1.0 mile of active spawn, numerous schools of herring, 8 sea lions, 1 whale, 2,500 scoters.
5/13 Skiff Survey: No herring spawn and very few predators.
5/24 Skiff Survey: additional 0.8 nmi of eggs found.

Port Houghton
Total miles of spawn: ~0.27 nm
Spawning dates: 4/27 and 5/12
Peak spawning: unknown

4/22 No herring spawn, 3 schools of herring, 50 gulls.
4/25 No herring spawn or schools observed, 19 sea lions, 50 gulls, 50 scoters.
4/27 ~0.27 miles of active spawn, 1 school of herring, 16 sea lions, 1 whale, few birds.
4/28 No herring or herring spawn observed, 31 sea lions, 200 gulls, 400 scoters.
4/30 No herring or herring spawn observed, 15 sea lions, 3 whales, few birds.
5/4 No herring spawn or schools observed, 4 sea lions, 600 scoters, 200 gulls.
5/7 No herring spawn or schools observed, no predators.
5/9 No herring spawn or schools observed, 2 sea lions, 500 scoters.
5/10 No herring spawn or schools observed, 2 sea lions.
5/12 One spot spawn and one small school of herring, 2 sea lions, 2,000 scoters.

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Sunset Cove/Windham Bay
Total miles of spawn: ~1.0 nm
Spawning dates: 5/9
Peak spawning: unknown

4/22 No herring spawn or schools observed, 2 sea lions
4/25 No herring spawn or schools observed, no sea lions, 50 gulls.
4/27 No herring spawn or schools observed, no sea lions, few birds.
4/28 No herring spawn or schools observed.
4/30 No herring spawn or schools observed.

Gambier Bay/Pybus Bay, Port Camden, Tebenkof Bay
Not surveyed in 2022

Appendix C4.–Aerial and skiff herring spawn surveys by date, in Juneau Management Area, in Southeast Alaska, 2022.

Seymour Canal

Number of times surveyed: 19
Total miles of spawn: 1.4 nmi
Spawning dates: 5/21-22 (spot spawns); 5/31-6/2
Peak spawn: 5/31
4/15: No herring or herring spawn; 23 SL, 1W; Excellent vis.
4/20: No herring or herring spawn; 54 SL, 1W; Excellent vis.
4/25: No herring or herring spawn; 25 SL, 0W; Good vis, fog prevented upper Seymour survey (started at Sorefinger and went south)
4/28: No herring or herring spawn; 26SL, 5W; Excellent vis.
5/2: No herring or herring spawn; 54SL, 2W; Good vis
5/6: No herring or herring spawn; 76SL, 9W. Excellent vis.
5/9: No herring or herring spawn; 72SL, 3W; excellent vis.
5/12: No herring or herring spawn; 68SL, 1W. Good vis
5/16: No herring or herring spawn; 63SL, 1W. fair vis.
5/18: No herring or herring spawn; 48SL, 3W. Good vis.
5/20: Schools on outside of Glass Peninsula and Pt Hugh, no spawn; 55SL, 2W; good vis
5/21: Schools on inside from Twins Islands north to Sorethumb Cove, **0.1 nmi of light spawn** north of Twin Islands; 65SL, 9W; excellent vis.
5/22: Schools everywhere in Seymour Canal including Fool Inlet in the far north, from Winning Cove south to Sorethumb, and from Cloverleaf Rocks south towards Pt. Hugh (only schools lining the beach were on outside and around Sorethumb), **spot spawn** inside Sorethumb Cove; 69SL, 4W; excellent vis
5/23: No herring or herring spawn; 18SL, 1W; fair vis.
5/25: Schools north of Cloverleaf Rocks, no spawn; 22SL, 2W; excellent vis
5/27: Schools offshore around Blackjack Cove and south of Cloverleaf Rocks; 11SL, 1W; good vis
5/31: **1.3nmi of active spawn** around Point Hugh, one school in Sorethumb Cove; excellent vis
6/1: **.04nmi** in cove west of Point Hugh, one school south of Twin Islands, 2 schools north of Sorethumb cove; excellent vis
6/2: **Spot spawn** in same cove as previous day, one school near Swimming Pool; excellent vis

Tenakee Inlet

Number of times surveyed: 7
Total miles of spawn: 0
Spawning dates: none
Peak spawn: none
4/15: No herring or herring spawn; 4 SL, 1W; excellent vis; 130 SL at Cannery Point haulout
4/20: No herring or herring spawn; 32 SL, 0W; Excellent vis; 100 SL at Cannery Pt
4/25: No herring or herring spawn; 13SL, 0W; Good vis; Cannery Pt full
4/28: No herring or herring spawn; 39SL, 0W; Excellent vis; 30 SL at Cannery Pt
5/2: No herring or herring spawn; 15 SL, 0W; good vis; Cannery Pt nearly empty
5/6: No herring or herring spawn; 17 SL, 1W. Excellent vis.; Cannery Pt empty
5/18: No herring or herring spawn; 16SL, 0W; good vis.

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Chatham Strait (Tenakee area/stock)

Number of times surveyed: 7
Spawn dates: 4/28 (spot spawns observed by A. Dupuis)
Total miles of spawn observed: about 0.1

4/15: No herring or herring spawn; 10 SL, 0W; Excellent vis.
4/20: No herring or herring spawn; 15SL, 0W; excellent vis
4/25: No herring or herring spawn; 12 SL, 2 W; vis good.
4/28: No herring or herring spawn on morning survey; 13SL, 0W; Excellent vis. **Spot spawns** off Point Hayes observed by Aaron Dupuis on late afternoon survey.
5/2: No herring or herring spawn; 27SL, 0W; good vis.
5/6: No herring or herring spawn; 37SL, 0W; Excellent vis.
5/18: No herring or herring spawn; 1SL, 0W. good vis.

Lynn Canal

Number of times surveyed: 11
Total miles of spawn: 1.4 nmi
Spawning dates: 5/9-11
Peak spawn: 5/9

4/15: No herring or herring spawn; 18 SL, 0W; Excellent vis.
4/20: No herring or herring spawn; 24 SL, 1W. Excellent vis.
4/25: No herring or herring spawn; 26 SL, 0W; good vis
4/28: No herring or herring spawn; 300-400SL, 1W; Excellent vis. Huge rafts of SL off mouth of Berners River – likely targeting eulachon
5/2: No herring or herring spawn; 49SL, 10W; good vis; most action between Pt Sherman and Pt St Mary; good vis
5/4: No herring or herring spawn; 45SL, 4W; good vis.
5/6: No herring or herring spawn; 15SL, 1W; excellent vis.
5/9: **1.3nmi of spawn** south of Pt Sherman, herring school north of active spawn
5/11: **0.1nmi of light spawn** just south of previous, no schools
5/12: 1 school in Auke Bay, no herring spawn; 43SL, 1W; good vis.
5/18: 2 schools in Auke Bay, no herring spawn; 14SL, 0W; good vis

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Oliver Inlet and northern Stephens Passage

Number of times surveyed: 20
Spawning dates: 5/20-23
Peak Spawn: 5/21-23
Total miles of spawn: 3.6 nmi

4/15: No herring or herring spawn; 1 SL, 0W; Excellent vis.
4/20: No herring or herring spawn; 0 SL 0W. Excellent vis.
4/25: No herring or herring spawn; 0 SL, 0W; good vis.
4/28: No herring or herring spawn; 0SL, 0W; Excellent vis.
5/2: No herring or herring spawn; 0SL, 0W; good vis.
5/6: No herring, herring spawn, or predators. Excellent vis.
5/9: No herring, herring spawn, or predators. excellent vis.
5/12: Multiple schools in Olivers Inlet, no spawn; no predators; Good vis.
5/16: Multiple schools in Olivers Inlet, no spawn; no predators; fair vis.
5/18: Multiple schools in Olivers Inlet, no spawn; no predators; good vis.
5/20: **Spot spawn** at eastern entrance to Olivers Inlet, several schools on beach east of spawn, fewer schools in Olivers Inlet
5/21: **1.7 nmi of active spawn** on both sides of entrance to Olivers Inlet, schools lining the beach towards Greens Cove and inside Olivers Inlet
5/22: **0.4 nmi of active spawn** on west side of entrance to Olivers, very large school at entrance to Olivers, a couple small schools inside Olivers, schools observed on back side of Douglas Island and Fritz Cove
5/23: **2.4 nmi of active spawn** predominantly extending west to Stink Creek, one school east of Greens Cove
6/2: No herring or spawn
5/24: No herring spawn, 1 school west of Stink Creek, 5 small schools inside Olivers; good vis
5/25: No herring or spawn
5/27: No herring or spawn
5/31: No herring or spawn
6/1: No herring or spawn

Port Frederick

Number of times surveyed: 6
Spawn dates: none
Total miles of spawn observed: 0

4/15: No herring or spawn; 7SL, 0W; excellent vis.
4/20: No herring or spawn. 9 SL, 1W; Excellent vis.
4/25: No herring or spawn; no predators; good vis.
4/28: 2 nice herring schools north of Hoonah Harbor, no spawn; 4 SL, 1W; excellent vis.
5/2: No herring or spawn; 1 SL, 0W; good vis.
5/18: 1 school east of Burnt Pt, no spawn; 5SL, 0W; good vis.

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Taku Habor

Number of times surveyed: 2
Spawn dates: none
Total miles of spawn observed: 0

5/12: no herring schools, spawn, or predators; good vis.
6/2: no herring schools or spawn; 1 whale rolling in the mud at the head

Appendix C5.–Aerial and skiff herring spawn surveys by date, in the Yakutat Management Area, in Southeast Alaska, 2022.

Yakutat Bay

Boat surveys were conducted during April 18 to 26, 2022 the areas of Doggie Island, Northern Khantaak Island, Redfield Cove, and Puget Cove. Cumulative spawn mileage totaled 1.8 nmi.